

NAVAL SHIPS' TECHNICAL MANUAL

CHAPTER 631

VOLUME 1

**PRESERVATION OF SHIPS IN
SERVICE - GENERAL**

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CHAPTER 631

PRESERVATION OF SHIPS IN SERVICE VOLUME 1. GENERAL

SECTION 1. GENERAL INFORMATION

631-1.1 INTRODUCTION

631-1.1.1 This chapter provides instructions, requirements, and information for prevention of corrosion and deterioration of ships, boats, and small craft in the naval service by means of surface preparation, painting, and application of other preventive measures.

631-1.2 REFERENCE DOCUMENTS

631-1.2.1 Reference documents are listed in [Table 631-1-1](#).

631-1.3 TRAINING FILM

631-1.3.1 A training film, MN 76C, Painting Ships and Boats, is available from the Naval District Training Aid Section.

631-1.4 PAINTING GUIDELINES

631-1.4.1 GENERAL. Painting of the ships' surfaces, interior and exterior, should be considered only when it is necessary to prevent corrosion or deterioration of the surfaces. The repainting of surfaces shall be done with the compatible coating specified either in the ship painting schedule or in this chapter. Soiled surfaces should be cleaned rather than repainted. Guidelines for the painting of the ships' surfaces are described in paragraphs [631-1.4.3](#) through [631-1.4.5](#). Refer to Section 6, Volume 2, for more detailed guidance and [Table 631-1-2](#), [Table 631-1-3](#), [Table 631-1-4](#) and [Table 631-1-5](#) for a general summary of coating requirements.

631-1.4.2 SHIPS' EXTENDED OPERATING CYCLES. Ships which participate in Extended Operating Cycles (EOC) are exceptions to this rule. For these ships, consideration should be given to replacing, at every overhaul, coating systems which are most essential to ship preservation. These critical systems include underwater hull areas and most tanks. On a case basis, guidance should be requested from the Naval Sea Systems Command (NAVSEA), through the Type Commander or the Naval Ship Systems Engineering Station (NAVSSSES), Philadelphia, PA. The specific ship guidance given will be based on the condition of existing coatings, scheduled overhaul cycles, capability of refit activities to perform anticipated maintenance, cost of repainting, and other factors.

631-1.4.3 INTERIOR SURFACES. In repainting interior surfaces, the minimum number of coats required for satisfactorily hiding a surface should be applied. One coat is usually sufficient.

631-1.4.4 EXTERIOR SURFACES. In exterior painting, touching up (rather than complete repainting) should be considered. When small areas to be touched up are cleaned to bare metal, the edges of adhering paint should be mechanically cleaned (feathered) to a tapering edge. Repainting should be done in such a way that the junction of old and new paint has as natural an appearance as possible. When light blasting (brush blasting) is done, at least two coats of anti-corrosive paint shall be applied before topcoats of anti-fouling paint.

631-1.4.5 METAL SURFACES. Unpainted metal surfaces should be kept to a minimum. If bearing surfaces and bright steel surfaces are not frequently used or handled, they should be protected with corrosion preventive compounds insofar as practical. Surfaces that are not protected should be cleaned frequently to minimize corrosion. Care shall be taken to prevent damage to the surface. Unpainted steel not serving as a bearing surface should be polished with emery cloth.

631-1.4.6 NAVSEA DIRECTIVE FOR CHANGING PAINTING PRACTICES. Whenever a directive is issued by NAVSEA effecting a change in painting practice, repainting to conform with the directive should be deferred until repainting is necessary, unless the directive specifies that repainting shall be done as soon as practical.

631-1.4.7 COATING WEIGHT. Coating selection should include consideration of coating weight for the area or space to be coated. Weight per mil-square-foot multiplied by the total surface area to be coated gives a comparative figure that can be used for identifying the lowest coating weight of coatings under consideration. Using lower weight coating system aids in overall weight savings on the ship which increases fuel savings and/or increases speed.

631-1.5 COATING SELECTION.

Coatings selected for application shall be lead free, chromate free, asbestos free, cadmium free and comply with all Federal, state and local regulations which regulate the emission of volatile organic compounds (VOC) into the atmosphere. See paragraph [631-3.4.8](#) and [Table 631-3-7](#).

NOTE

The paints and coatings, as well as the safety application information, listed in this manual have been reviewed for compliance with environmental and occupational safety and health compliance to the rules and regulations in effect on the date of the latest change notice. Fleet and shore activities procuring and using paints other than those listed herein have the responsibility of verifying that the paints comply with all such rules, regulations and laws.

Table 631-1-1 REFERENCE DOCUMENTS

DOCUMENT NUMBER	TITLE
ANSI Standard Z9.2 ⁴ , Occupational Safety and Health Administration (OSHA)	Fundamentals Governing the Design and Operation of Local Exhaust Systems
DODINST 6055.5M	Occupational Health Surveillance Manual
DOD-STD-2138(SH)	Metal Sprayed Coating Systems for Corrosion Protection Aboard Naval Ships
NAVFAC MO-110	Paints and Protective Coatings
NAVMED P-5010	Manual of Naval Preventive Medicine, Chapter 6, Water Supply Afloat
NAVMEDCOMINST 6260.3	Occupational Health Medical Surveillance

Table 631-1-1 REFERENCE DOCUMENTS - Continued

DOCUMENT NUMBER	TITLE
NEHC TM 91-1	Medical Surveillance Procedures
NEHC TM 92-2	Reproductive Hazards in the Workplace
NAVSEA 0900-LP-016-0010	Manual of Cargo Tank Cleaning
NAVSEA SE110-BK-MMO-010	Procedures for Inspection, Repair and Painting of Fiberglass Mast Assemblies
NAVSEA 0900-LP-082-3010	Ship Hull Structure Maintenance and Repair Manual (Aluminum Hull Surface Ships)
SOBT Video SVT-GT-9336	Submarine Paint and Preservation Video
NAVSEA 0900-LP-008-0010	Glass Reinforced Coating for Propeller Shafting
NAVSEA 0929-LP-002-7010	U.S. Navy Shipboard Color Coordination Guidance Manual
NAVSEA 0967-LP-000-0110	Electronic Installation Maintenance Book, Installation Standards
NAVSEA 0967-LP-052-8280	TTR Radar Set
NAVSEA 0967-LP-221-1010	Radar Antenna
NAVSEA 0967-LP-412-3010	Sonar Dome Handbook, Vol. I, AN/SQS-4 Series and AN/SQS-23 Sonar Domes
NAVSEA 0967-LP-412-3020	Sonar Dome Handbook, Vol. II, AN/SQS-26 Steel and Rubber Sonar Domes
NAVSEA 0967-LP-412-3030	Sonar Dome Handbook, Vol. III, AN/SQS-38 GRP Sonar Domes
NAVSEA 0967-LP-412-3040	Sonar Dome Handbook, Vol. IV, AN/SQQ-23 Rubber Sonar Domes
NAVSEA 0967-LP-559-7011	Installation and Dome Grooming Procedures for the ILS Acoustic Group
NAVSEA 0967-LP-559-7020	Installation and Dome Grooming Procedures
NAVSEA 0989-LP-037-2000	Commissioned Submarine General Reactor Plant Overhaul and Repair Specifications
NAVSEA 0989-LP-043-0000	Commissioned Surface Ship General Reactor Plant Overhaul and Repair Specifications
NAVSEA 250.342-1	Handbook of Cleaning Practices
NAVSEAINST 9210.36	Steam Plant Cleanliness Control
NAVSUPPUB 4105	Navy Shelf Life Items
NAVSUPPUB 4500	Consolidated Hazardous Item List (CHIL)
OPNAVINST 5100.10	Navy Safety Precautions for Forces Afloat
OPNAVINST 5100.23	Navy Occupational Safety and Health (NAVOSH) Program
OPNAVINST 6240.3	Environmental Protection Manual
OPNAVINST 6260.2	Occupational Noise Control and Hearing Conservation
OPNAVINST 5100.19	Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat
S6360-AG-MAN-010	Camouflage Manual for Surface Ship Concealment
S6360-AD-HBK-010	SHT Maintenance and Repair Handbook
S9086-CH-STM-030	NSTM Chapter 074, Volume 3, Gas Free Engineering
S9086-CQ-STM-000	NSTM Chapter 081, Waterborne Underwater Hull Cleaning of Navy Ships
S9086-DA-STM-000	NSTM Chapter 100, Hull Structures
S9086-KC-STM-010	NSTM Chapter 300, Electric Plant - General
S9086-KE-STM-000	NSTM Chapter 302, Electric Motors and Controllers
S9086-ND-STM-000	NSTM Chapter 400, Electronics
S9086-RK-STM-010	NSTM Chapter 505, Piping Systems
S9086-TV-STM-010	NSTM Chapter 581, Anchoring

Table 631-1-1 REFERENCE DOCUMENTS - Continued

DOCUMENT NUMBER	TITLE
S9086-TX-STM-010	NSTM Chapter 583, Boats and Small Craft
S9086-T8-STM-010	NSTM Chapter 593, Pollution Control
S9086-VG-STM-010	NSTM Chapter 634, Deck Coverings
S9086-VH-STM-010	NSTM Chapter 635, Thermal, Fire, and Acoustic Insulation
S9086-WK-STM-010	NSTM Chapter 670, Stowage, Handling, and Disposal of Hazardous General Use Consumables
S9165-AC-HBK-010	Submarine Sonar Dome Handbook
SE300-BA-MMA-011	SSN-594, 637 and 688 Class Glass Reinforced Plastic (GRP) Bow Sonar Domes
SSPC-SP-5 ¹	White Metal Blast Cleaning
SSPC-SP-6 ¹	Commercial Blast Cleaning
SSPC-SP-7 ¹	Brush-Off Blast Cleaning
SSPC -SP-10 ¹	Near White Blast Cleaning
SSPC-SP-11 ¹	Power Tool Cleaning to Bare Metal
SSPC-VIS-1-89 ¹	Visual Standards for Abrasive Blast Cleaned Steel
Standard TM-01-70 ²	Visual Standard for Surfaces of New Steel Air-Blast Cleaned with Sand Abrasive
Standard Z9.2	American National Standard Institute (ANSI)
Tech and Research Bulletin #4-21 ³	Abrasive Blasting Guide for Aged or Coated Steel Surfaces
U.S. Department of Labor Publication	Shipboard Ventilation for Hazardous Atmosphere
UIPI 6311-455	Bilge Cleaning - Citric Acid, Surface Preparation Process
UIPI 0631-901	Electrostatic Powder Spray
UIPI 0630-901	Tanks and Voids, Steel Grit Blasting
UIPI 6313-N005	Removal of Organic Coatings

NOTES:

1. Available from Steel Structures Painting Council (SSPC), 4515 Henry Street, Suite 301, Pittsburgh, PA 15213-3728.
2. Available from National Association of Corrosion Engineers (NACE), P.O. Box 218340, Houston, TX 77218-8340.
3. Available from the Society of Naval Architects and Marine Engineers (SNAME), 601 Pavonia Avenue, Jersey City, NJ 07306
4. Available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036
5. The Following Publications and Documents are Provided for Information Purposes:
 - (I) Document Number: ANSI B1 65.1", Document Title:
"Safety Requirements for the Design, Care and use of Power Tools, and Power-driven Brushing Tools."
 - (II) Document Number: ANSI Z41", Document Title:
"Personnel Protection - Protective Footwear."
 - (III) Document Number: ANSI Z87.1", Document Title:
"Practice for Occupational and Educational Eye and Face Protection."

- (IV) Document Number: "29 Code of Federal Regulations (CFR) Parts 1900-1910", Document Title: "Safety and Health Regulations for General Industry."
 - (V) Document Number: "29 CFR Part 1926", Document Title: "Safety and Health Regulations for Construction."
 - (VI) Document Number: "40 CFR Parts 50-59", Document Title: "Air Pollution Control Regulations."
 - (VII) Document Number: "40 CFR Parts 100-149; Parts 400-699", Document Title: "Clean Water Act (CWA) Regulations."
 - (VIII) Document Number: "40 CFR Parts 150-189", Document Title: "Federal Insecticide, Fungicide and Rodenticide (FIFRA) Regulations."
 - (IX) Document Number: "40 CFR Part 172", Document Title: "Hazardous Materials Table, Special Provisions Hazardous Materials Communications, Emergency Response and Training Requirements Regulations."
 - (X) Document Number: "40 CFR Parts 260-280", Document Title: "Resource Conservation and Recovery Act (RCRA) Regulations."
 - (XI) Document Number: "40 CFR Parts 700-799", Document Title: "Toxic Substances Control Act (TSCA) Regulations."
 - (XII) Document Number: "ANSI/NSF 61", Document Title: "Drinking Water Components - Health Effects."
6. The Following Standards are also Available from the Steel Structures Painting Council:
- (I) Document Number: "SSPC-SP 1", Document Title: "Surface Preparation Specification No. 1 - Solvent Cleaning."
 - (II) Document Number: "SSPC-SP 2", Document Title: "Surface Preparation Specification No. 2 - Hand Tool Cleaning."
 - (III) Document Number: "SSPC-SP 3", Document Title: "Surface Preparation Specification No. 3 - Power Tool Cleaning."
 - (IV) Document Number: "SSPC-SP 11", Document Title: "Surface Preparation Specification No. 11 - Power Tool Cleaning to Bare Metal."
 - (V) Document Number: "SSPC-PA Guide 3", Document Title: "A Guide to Safety in Paint Application."
 - (VI) Document Number: "SSPC-PA Vis 1", Document Title: "Visual Standard for Abrasive Blast Cleaned Steel."
 - (VII) Document Number: "SSPC-PA Vis 3", Document Title: "Visual Standard for Power- and Hand-Tool Cleaned Steel."

Table 631-1-2 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS-EXTERIOR

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Underwater hull (keel to lower boottop) including rudders, struts, and cavitation prone areas	Near white blast or for hydroblasted surfaces, use International/ Courtaulds Marine Paint Company hydroblasting standard very thorough hydroblast HB 2 1/2 L	631-5.4.7.2	1) 1 or 2) 2 or 3) 3	631-8.23.2	1) 25-28 2) 12.0 3)--	N/A	N/A	See Section 2	Overhaul surface preparation may require only spot blasting to near white and will require inspection. See Table 631-8-10 for coatings for rudders, struts, and cavitation prone areas.
Lower boottop limit to 12" above the upper boottop limit	Near white blast	631-5.4.7.2	1) 1 or 2) 4 or 3) 3	631-8.23.2	1) 25-28 2) 12.0 3) --	Near white blast 631-5.4.7.2	1) 1 or 2) 3 or 3) 4	See Section 2	Touch-up existing coatings with the same system. Do not put epoxies over vinyls.
Exterior vertical and near vertical from 12" above the upper boottop	Near white blast	631-5.4.7.2	1) 22 or 2) 5	631-8.23.2	1) 12.0 2) 9.5	Near white blast 631-5.4.7.2 or power tool 631-5.3.3 and needle gun	5	See Section 2	Touch-up existing coatings with the same system. Do not put epoxies over vinyls or alkyds or vinyls over alkyds. Edges shall be feathered to "tie in" coatings.

Table 631-1-2 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS-EXTERIOR -

Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Exterior horizontal surfaces and waterways	Near white blast	631-5.4.7.2	1) 7 or 2) 6	631-8.23.2	1) 9.5 2) 9.0	Near white blast 631-5.4.7.2 or power tool 631-5.3.3 and needle gun	6	See Section 2	Touch-up existing coatings with the same system. Do not put epoxies over vinyls or alkyds or vinyls over alkyds. Edges shall be feathered to "tie in" coatings.
Exterior fittings and piping	Near white blast	631-5.4.7.2	1) 5 or 2) 22	631-8.23.2	1) 9.0 2) 12.0	Power tool clean 631-5.3.3	5	See Section 2	Do not interchange systems.
Anchor	Near white blast	631-5.4.7.2	8	631-8.21	1) 9.0	Power tool clean 631-5.3.3	8	See Section 2	
Anchor chains	Near white blast	631-5.4.7.2	23	631-8.21	10	Power tool clean 631-5.3.3	23	See Section 2	See Table 631-8-9, note 21
Antenna insulator fittings	Hand clean or power tool	631-5.3.2 or 631-5.3.3	1) 9 or 2) 10	631-8.21	1) 3.0 2) 5.0	Hand clean or power tool	1) 9 or 2) 10	See Section 2	System 10 is preferred. Do not mix systems. Remainder of rigging and insulators shall be kept free of paint.
Catapult launching valves and exhaust	Near white blast (white metal if WSA)	631-5.4.7.2	1) 21 or 2) 12	631-8.21	1) -- 2) 8.0 3) 9.0	Near white blast 631-5.4.7.2	1) 21 or 2) 11 or 3) 12	See Section 2	See DOD-STD-2138 and NSTM Chapter 632 for system requirements.

Table 631-1-2 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS-EXTERIOR -

Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Exterior canvas lagging and life rafts	Detergent clean and rinse, dry		13	631-8.21		Detergent clean and rinse, dry	13	See Section 2	
Fire plugs and foam discharge valves	Near white blast	631-5.4.7.2	14 and 15	631-8.21	6.5	Power tool clean 631-5.3.3 or hand clean 631-5.3.2	14 and 15	See Section 2	
Messenger buoys	Detergent clean and rinse, dry		16	631-8.21	9.0	Detergent clean and rinse, dry	16	See Section 2	
Propellers (composition or corrosion resistant)	Clean and polish bright					N/A	N/A		
Ring buoys	3 coats orange plastic compound								
Rudder and skegs (internal surfaces)			17	631-8.21	Fill and drain or float coat		17	See Section 2	
Shafting inboard	Hand clean	631-5.3.2	18	631-8.21	9.0	Hand clean 631-5.3.2	18	See Section 2	Hand clean to prevent damage. Do not mix systems.
Shafting outboard									Follow instructions in MIL-R-15058.
Shaft tube (internal)	Hand clean	631-5.3.2	19	631-8.21	9.0	Hand clean 631-5.3.2	19	See Section 2	Hand clean to prevent damage.

Table 631-1-2 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS-EXTERIOR -

Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Smoke pipes	Near white blast	631-5.4.7.2	20	631-8.21	3.0	Hand clean 631-5.3.2 power tool clean 631-5.3.3	20	See Section 2	Unless WSA has been specified.
Sonar domes	See 631-8.20								
Well deck overheads	Near white blast or power tool cleaning	631-5.2.4.1.4	11 2 cts or 12	Table 631-8-10	10	Hand clean 631-5.3.2 or power tool clean 631-5.3.3	11 2 cts or 12	See Section 2	Well deck overheads of LCAC capable ships have specific surface preparation and coating requirements. See sections 5 and 8 for details.

* COATING SYSTEMS

* Coating Systems:

NOTE

Except for potable water tanks and feedwater tanks, MIL-P-24441 epoxy paints may be applied as either a Type III three coat system (i.e., 150/151/152) or as a Type IV two coat system (i.e., 150/151/152) or where any Type III, MIL-P-24441 paint is specified, the equivalent type IV MIL-P-24441 coating may be substituted. Unless otherwise stated in this technical manual or specified in work orders, total dry film thickness of the two coat Type IV system is to be the same as the thickness of the three coat Type III system. Potable water tank and feedwater tank coating systems and application remain unchanged (see 631-8.8 and 631-8.9).

Table 631-1-3 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS - INTERIOR

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Potable Water Tanks	Near white blast	631-5.4.7.2	1) 1 or 2) 2	631-8.8.3 631-8.8.3	1) 8.0 2) --	Power tool clean 631-5.3.3	1) 1 or 2) 2	631-2.2.12 631-2.4.1.4 631-2.5 See Section 2	Surface to be completely clean and not polished. White, green, gray, and red MIL-P-24441 are interchangeable. Feather edges.
Feedwater Tanks, Reserve Feed Innerbottom Tanks	Near white blast	631-5.4.7.2	1) 3 or 2) 4 or 3) 2	631-8.9.1	1) 8.0 2) -- 3) --	Power tool clean 631-5.3.3	1) 3 or 2) 4 or 3) 2	631-2.2.12 631-2.4.1.4 631-2.5 See Section 2	Surface to be completely clean and not polished. Feather edges.
Drainage Tanks, Compensating Fuel Ballast Tanks	Near white blast	631-5.4.7.2	1) 3 or 2) 18	631-8.23.10	1) 8.0 2) --	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	1) 3 or 2) 18	631-2.2.12 631-2.4.1.4 631-2.5 See Section 2	
Peak Tanks	Near white blast	631-5.4.7.2	1) 18 or 2) 27	631-8.23.10	1) -- or 2) 8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	1) 18 or 2) 27	631-2.2.12 631-2.4.1.4 631-2.5 See Section 2	
Seawater Tanks	Near white blast	631-5.4.7.2	31	631-8.23.10	12; 20 on edges	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	31	631-2.2.12 631-2.4.1.4 631-2.5 See Section 2	

Table 631-1-3 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS - INTERIOR -

Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
CHT Tanks, Sanitary Tanks	Near white blast	631-5.4.7.2	28	631-8.23.10	10	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	28	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Tanks for Jet Fuel, Gasoline, Diesel Fuel, Fuel Oil Service, Contaminated Fuel; Fuel or Ballast Tanks	Near white blast	631-5.4.7.2	1) 3 or 2) 18	631-8.23.10	1) 8.0 or 2) --	Degrease, solvent wipe, power tool clean 631-5.3.3	1) 3 or 2) 18	631-2.2.12 631-2.4.1.4 631-2.5 See Section 2	
Lubricating Oil Tanks	Near white blast	631-5.4.7.2	30	631-8.23.10			30		Maintain preservation until filled.
Locked in Fresh Water Ballast									NAVSEA approved coatings for potable or feedwater tanks may be used.
Silicone Bronze Diesel Fuel Tanks	Abrasive blast or power tool clean	631-5.4.7.2 or 631-5.3.3	1) 3 or 2) 18	631-8.23.10	1) 8.0 2) --	Power tool clean 631-5.3.3 or hand clean 631-5.3.2	1) 3 or 2) 18	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	

Table 631-1-3 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS - INTERIOR -

Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Floodable but Normally Empty Voids	Near white blast	631-5.4.7.2	1) 3 or 2) 18 or 3) 14 or 4) 16	631-8.23.10	1) 8.0 or 2) -- or 3) -- or 4) 3.0 to 5.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	1) 3 or 2) 18 or 3) 14 or 4) 16	631-2.2.12 631-2.5 See Section 2	Touch-up with existing system.
Non-Floodable Void	Near white blast	631-5.4.7.2	1) 26 or 2) 18 or 3) 17 or 4) 16	631-8.23.10	1) 6.0 or 2) -- or 3) -- or 4) 3.0 to 5.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	1) 26 or 2) 18 or 3) 17 or 4) 16	631-2.2.12 631-2.5 See Section 2	Touch-up with existing system.
Small Inaccessible Voids	Hand clean is possible		14	631-8.23.10		Hand clean is possible	14	631-2.2.12 631-2.5 See Section 2	
Catapult Gravity Tank	Near white blast	631-5.4.7.2	1) 3 or 2) 18	631-8.23.10	1) 8.0 or 2) --	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	1) 3 or 2) 18	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Chain Lockers	Near white blast	631-5.4.7.2	1) 24 or 2) 18 or 3) 25	631-8.23.10	1) 8.0 or 2) -- or 3) 12	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	1) 24 or 2) 18 or 3) 25	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	

Table 631-1-3 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS - INTERIOR -

Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Structure and fitting below floor plates in machinery spaces (bilges, bilge wells, and sumps), including bottoms and edges of floor plates	Near white blast	631-5.4.7.2	1) 29 or 2) 18	631-8.23.10	1) 8.0 or 2) --	Power tool clean 631-5.3.3 or hand clean 631-5.3.2	1) 29 or 2) 18	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	Touch-up with existing system.
Surfaces subject to exposure to MIL-H-19457 hydraulic fluid	Near white blast	631-5.4.7.2	1) 3 or 2) 18	631-8.21	1) 9.0 or 2) 8.0	Degrease, solvent wipe, hand clean 631-5.3.2	1) 3 or 2) 18	631-2.2.12 631-2.5 See Section 2	Surface to be completely clean and not polished. Feather edges.
Ferrous machinery surfaces (unheated, external and internal)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	1) 6 or 2) 5	631-8.10	1) 4.5 2) 4.5	Hand clean or power tool clean 631-5.3.2 and 631-5.3.3	1) 6 or 2) 5	631-2.2.12 631-2.4.1.2 631-2.4.1.3 631-2.5 See Section 2	
Ferrous sheet metal surfaces (unheated, external and internal)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	6	631-8.10	4.5	Hand clean or power tool clean 631-5.3.2 and 631-5.3.3	6	631-2.2.12 631-2.4.1.2 631-2.4.1.3 631-2.5 See Section 2	

Table 631-1-3 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS - INTERIOR -

Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Ferrous sheet metal surfaces (unheated, external and internal)	Near white blast or power tool clean (White metal if WSA)	631-5.4.7.2 or 631-5.3.3	7	631-8.10	1.0	Hand clean or power tool clean 631-5.3.2, 631-5.3.3	7	631-2.2.12 631-2.2.15.3 631-2.5 631-2.2.15.2 See Section 2	Unless wire sprayed aluminum is specified. See Section 2 for carbon monoxide (CO) monitoring.
Ferrous machinery surfaces (unheated, external and internal)	Near white blast or power tool clean (White metal if WSA)	631-5.4.7.2 or 631-5.3.3	7	631-8.10	1.0	Hand clean or power tool clean 631-5.3.2, 631-5.3.3	7	631-2.2.12 631-2.2.15.3 631-2.5 631-2.2.15.2 See Section 2	Unless WSA is specified, see Section 2 for carbon monoxide monitoring.
Machinery gage boards (including gages and clocks)	Power tool or hand clean	631-5.3.2 or 631-5.3.3	8	631-8.10	4.5	Hand clean 631-5.3.2	8	631-2.2.12 631-2.4.1.2 631-2.4.1.3 631-2.5 See Section 2	
Thermally insulated machinery, valves, and piping	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	9	631-8.10	1.0 plus 1.5 finish	Hand clean 631-5.3.2	9	631-2.2.12 631-2.2.15.3 631-2.5 See Section 2	See Section 2 for carbon monoxide monitoring
Gasoline piping and valves (exterior)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	10	631-8.10	3.0	Hand clean or power tool clean 631-5.3.2 631-5.3.3	10	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	

Table 631-1-3 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS - INTERIOR -

Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Oxygen piping and valves (exterior)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	10	631-8.10	3.0	Hand clean or power tool clean 631-5.3.2 or 631-5.3.3	10	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
JP-5 piping and valves (exterior)	Near white blast or power tool clean	631-5.4.7.2	10	631-8.10	4.5	Hand clean or power tool 631-5.3.2, 631-5.3.3	6	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
Boilers and economizers (except parts used for heat transfer)	Near white blast or power tool clean (white metal if WSA)	631-5.4.7.2 or 631-5.3.3	7	631-8.10	1.0	Hand clean or power tool 631-5.3.2, or 631-5.3.3	7	631-2.2.15.3 631-2.5 631-2.2.12 631-2.2.15.2 See Section 2	Unless WSA is specified, see Section 2 for carbon monoxide monitoring.
Piping, fittings, and valves (galvanized and ungalvanized steel, and aluminum)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	6	631-8.10	4.5	Hand clean 631-5.3.2	6	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	Hand cleaning only allowed on 08 cog. piping.
Nonferrous and corrosion resistant steel piping and valves, nonimmersion areas	Unpainted		Unpainted			None	None		Hand cleaning only allowed on 08 cog. piping.

Table 631-1-3 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS - INTERIOR -

Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Nonferrous and corrosion resistant steel piping and valves, immersion areas			Paint together with surrounding immersion areas				Same as initial		Hand cleaning only allowed on 08 cog. piping. These surfaces should be unpainted in the propulsion spaces of nuclear powered ships.
Electric and electronic equipment (except as otherwise indicated)	Hand clean or power tool clean	631-5.3.2 or 631-5.3.3	8	631-8.11	4.5	Hand clean 631-5.3.2	8	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
Motors and Generators (Exterior)	Hand clean or power tool clean	631-5.3.2 or 631-5.3.3	8	631-8.12.1	4.5	Hand clean 631-5.3.2	8	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	Except shafts and identification plate.
Motors and Generators (Interior)				631-8.12.2			631-8.12.2		
Electric Cables									See 631-8.14.

Table 631-1-3 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS - INTERIOR -

Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Metal Enclosures (Galvanized)	Hand clean or power tool clean	631-5.3.2 or 631-5.3.3	13	631-8.15	5	Hand clean 631-5.3.2	13	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
Metal Enclosures (Bare Steel)	Near white blast, power tool clean	631-5.4.7.2 631-5.3.3 631-5.3.2	12	631-8.15	5	Hand clean 631-5.3.2	12	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
Metal Enclosures (Aluminum)	Hand clean or power tool clean	631-5.3.2 or 631-5.3.3	6	631-8.15	5	Hand clean 631-5.3.2	6	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
Metal Enclosures (Miscellaneous Metals)	Hand clean or power tool clean	631-5.3.2 or 631-5.3.3	6	631-8.15	5	Hand clean 631-5.3.2	6	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	Brass, CRES, and non-ferrous metals other than aluminum are not coated except when required for appearance or camouflage.

Table 631-1-3 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS - INTERIOR -

Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Interior Communication and Fire Control Equipment			MIL-I-983 MIL-E-16400 MIL-E-18870	631-8.16		Hand clean 631-5.3.2	Same as metal enclosures	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
Lighting Systems	See 631-8.17						631-8.17		Do not paint light reflecting and light transmitting surfaces.
Electronic Equipment	See 631-8.19			631-8.19		Hand clean 631-5.3.2			
Bilge Keels Rudder Internals (Internal Surfaces)			14	Table 631-8-9	Heavy coat		14	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	Rudders may be filled and drained or float coated.
Furniture and Joiner Doors	MIL-F-902			Table 631-8-9			631-8.21		
Helmets	Hand clean	631-5.3.2	15	Table 631-8-9	4.5		631-8.21		Helmets should be recoated rather than touched up.
Inaccessible Surfaces (Galvanized and Non-ferrous)	Unpainted		Un-painted	Table 631-8-9		Unpainted			

Table 631-1-3 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS - INTERIOR -

Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Inaccessible Surfaces (Ungalvanized Steel)	Near white blast	631-5.4.7.2	16	Table 631-8-9	3.0	Near white blast 631-5.4.7.2 or power tool clean and needle gun 631-5.3.3	16	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	Touch-up surface must be equivalent in cleanliness to near white blast and have an anchor pattern.
Structure behind insulation	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	22	Table 631-8-9	5.0	Hand clean 631-5.3.2 or power tool clean 631-5.3.3	22	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
Ventilation Ducts and Trunks	Near white blast	631-5.4.7.2	1) 3 or 2) 25 or 3) 11	Table 631-8-9	1) 9.0 or 2) 10.5 or 3) --	Hand clean or power tool clean 631-5.3.2, 631-5.3.3	1) 3 or 2) 25 or 3) 11	631-2.2.12 631-2.5 See Section 2	Touch-up system (3) only with system (3), and system (25) only with system (25).
Seamless coating for small objects	See 631-7.5 to 631-7.5.6.1		See 631-7.5 to 631-7.5.6.1		See 631-7.5.2		See 631-7.5.6		Refer to 631-7.5 through 631-7.5.6.1.

Table 631-1-3 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS - INTERIOR -

Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Turntable Pits (LSTs)	Near white blast	631-5.4.7.2	18	Table 631-8-9	8.0	Degrease, solvent wipe, hand clean 631-5.3.2	18	631-2.2.12 631-2.5 See Section 2	Surfaces to be completely clean and not polished. Feather edges.
Interior bulkheads ** and overheads	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	19	631-8.23.3 631-8.23.3.1	4.5	Commercial blast 631-5.4.7.3, power tool clean 631-5.3.3, or hand clean 631-5.3.2	19	631-2.2.12 631-2.2.9.3 See Section 2	Use only F-84 on aluminum. Waterbase coatings approved for some applications.
Painting Behind Equipment (Interior)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	15	631-8.23.7	3.0	Power tool clean 631-5.3.3, hand clean 631-5.3.2	23	631-2.2.12 631-2.5 631-2.2.9.3 See Section 2	
Items not painted	See 631-8.22.1		See 631-8.22.1						631-8.22.1 is a list of shipboard items not to be painted.

Table 631-1-3 SUMMARY OF COATING REQUIREMENTS FOR SURFACE SHIPS - INTERIOR -

Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System *	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Interior Decks and Walking Surfaces	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	20	631-8.23.8	4.5	Commercial blast 631-5.4.7.3, power tool clean 631-5.3.3, hand clean 631-5.3.2	20	631-2.2.12 631-2.5 631-2.2.9.3 See Section 2	Use only F-84 on aluminum. Also see 631-8.23.6.1.
Fire Zone Bulkheads	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	21	631-8.23.5	12.0	Near white blast 631-5.4.7.2 power tool clean 631-5.3.3	21	631-2.2.12 631-2.5 See Section 2	
Wet Spaces (Wash rooms, water closets, bath and shower spaces, sculleries, vegetable prep. spaces)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	3	631-8.23.5	8.0	Power tool clean 631-5.3.3 or hand clean 631-5.3.2	3	631-2.2.12 631-2.5 See Section 2	Unless wire sprayed aluminum has been specified.

NOTE

Except for potable water tanks and feed water tanks, MIL-P-24441 epoxy paints may be applied as either a Type III three coat system (i.e., 150/151/152) or as a Type IV two coat system (i.e., 150/151/or 150/152) or where any Type III, MIL-P-24441 paint is specified, the equivalent Type IV MIL-P-24441 coating may be substituted. Unless otherwise stated in this technical manual or specified in work orders, total dry film thickness of the two coat Type IV system is to be the same as the thickness of the three coat Type III system. Potable water tank and feed-water tank coating systems and application remain unchanged (i.e., 631-8.8 and 631-8.9).

Table 631-1-4 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-EXTERIOR

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Keel to waterline at maximum beam; rudders and struts	Near white blast	631-5.4.7.2	1) 9 or 2) 1 or 3) 2	631-8.25.1	1) 25 - 28 2) 13 3) 12	N/A	N/A	See Section 2	For SHT use NAVSEA approved AF systems.
Water line at maximum beam to waterline in maximum condition diving trim, diving planes	Near white blast	631-5.4.7.2	1) 9 or 2) 3 or 3) 4	631-8.25.1	1) 25 - 28 2) 13 3) 12	N/A	N/A	See Section 2	
Wood slat decking	Clean and dry	631-5.2.5	5	631-8.25.1	7.0	Clean and dry	5	See Section 2	
Exterior aluminum and steel	Light abrasive blast	631-5.2.4.3	1) 6 or 2) 8	631-8.25.1	9.0	Power tool clean 631-5.3.3	1) 6 or 2) 8	See Section 2	System 6 may be used for touch-up of System 8 by ship's force.
Air induction piping	Near white blast	631-5.4.7.2	7	631-8.25.1	3.0	Near white blast 631-5.4.7.2 or power tool 631-5.3.3 and needle gun	7	See Section 2	
Exterior topsides	Near white blast	631-5.4.7.2	1) 6 or 2) 8	631-8.13.1	1) 9.0 2) 8.0	Near white blast 631-5.4.7.3 or power tool 631-5.3.3 and needle gun	1) 6 or 2) 8	See Section 2	System 6 can be used for touch-up of System 8 by ship's force.

* Coating Systems:

NOTE

Except for potable water tanks and feed water tanks, MIL-P-24441 epoxy paints may be applied as either a Type III three coat system (i.e., 150/151/152) or as a Type IV two coat system (i.e., 150/151 or 150/152) or where any Type III, MIL-P-24441 paint is specified, the equivalent Type IV MIL-P-24441 coating may be substituted. Unless otherwise stated in this technical manual or specified in work orders, total dry film thickness of the two coat Type IV system is to be the same as the thickness of the three coat Type III system. Potable water tank and feed water coating systems and application remain unchanged (i.e., 631-8.8 and 631-8.9).

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Auxiliary Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Bilges	Near white blast	631-5.4.7.2	5 or 3	631-8.25.7	9.0	Power tool clean 631-5.3.3 or hand clean 631-5.3.2	5 or 3	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	See Table 631-8-18.
Bilge Collecting Tanks/ Sumps	Near white blast	631-5.4.7.2	5 or 3	631-8.25.7	9.0	Power tool clean 631-5.3.3 or hand clean 631-5.3.2	5 or 3	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Bow Buoyancy Tanks	Near white blast	631-5.4.7.2	1	631-8.25.7	13.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	1	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Bow Sonar Tank (SSN 637, 671, and 688 Class)	Near white blast	631-5.4.7.2	1	631-8.25.7	13.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	1	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Chain Locker	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Clean Fuel Oil Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	Tanks originally unpainted shall remain unpainted.
Collecting Fuel Oil Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	Tanks originally unpainted shall remain unpainted.
Depth Control Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Diesel Fuel Oil Seawater Expansion Tanks (SSN 668 Class and 671)	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Diesel Generator Lubricating Oil Tank	Near white blast	631-5.4.7.2	None	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or hand clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	Maintain tanks in a cleaned and preserved state until used.

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Dirty Drain Collecting Tanks	Near white blast	631-5.4.7.2	3 or 5	631-8.25.7	9.0	Near white blast 631-5.4.7.2 or hand clean 631-5.3.3	8	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Drainage Trenches	Near white blast	631-5.4.7.2	5	631-8.25.7	9.0	Near white blast 631-5.4.7.2 or hand clean 631-5.3.3	5	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Feedwater Tank	Near white blast	631-5.4.7.2	2	631-8.25.7 and 631-8.9.1	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Fresh Water Drain Collecting Tank	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Fuel Oil Ballast Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Fuel Oil Expansion Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12	

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Fuel Oil Filter Sump Drain Tank (SSN 688 Class)	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12	
Fuel Oil Overflow Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Hovering Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Hydraulic Oil Tanks	Near white blast	631-5.4.7.2	None	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	None	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	CRES tanks are not painted.
Inaccessible Voids	Near white blast	631-5.4.7.2	7	631-8.25.7	Heavy coat	Hand clean if possible 631-5.3.2	7	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Lubricating Oil Collecting/ Settling Tanks	Near white blast	631-5.4.7.2	None	631-8.25.7		Power tool clean 631-5.3.3 or Near white blast 631-5.4.7.2			Maintain tanks in a cleaned and preserved state until used.

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Lubricating Oil Sludge Tanks	Near white blast	631-5.4.7.2	None	631-8.25.7		Power tool clean 631-5.3.3 or Near white blast 631-5.4.7.2			Maintain tanks in a cleaned and preserved state until used.
Lubricating Oil Stowage Tanks	Near white blast	631-5.4.7.2	None	631-8.25.7		Power tool clean 631-5.3.3 or Near white blast 631-5.4.7.2			Maintain tanks in a cleaned and preserved state until used.
Lubricating Oil Sumps	Near white blast	631-5.4.7.2	None	631-8.25.7		Power tool clean 631-5.3.3 or Near white blast 631-5.4.7.2			Maintain tanks in a cleaned and preserved state until used.
Main Ballast Tanks	Near white blast	631-5.4.7.2	1	631-8.25.7	13.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	1 or 3	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Main Induction Sump Tanks	Near white blast	631-5.4.7.2	8	631-8.25.7	9.0	Power tool clean 631-5.3.3 or hand clean 631-5.3.2	8	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Missile Tube Eject Chamber and Missile Compensating Tanks	Near white blast	631-5.4.7.2	5	631-8.25.7	9.0	Power tool clean 631-5.3.3 or hand clean 631-5.4.7.2	5	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Negative Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Non-Floodable Voids	Near white blast	631-5.4.7.2	1) 2 or 2) 3	631-8.25.7	8.0	Power tool clean 631-5.3.3 or hand clean 631-5.3.2	1) 2 or 2) 3	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Non-Oily Bilge Collecting Tanks	Near white blast	631-5.4.7.2	3 or 5	631-8.25.7	9.0	Power tool clean 631-5.3.3 or hand clean 631-5.3.2	8	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Non-Oily Drain Collecting Tanks (other than freshwater)	Near white blast	631-5.4.7.2	3 or 5	631-8.25.7	9.0	Power tool clean 631-5.3.3 or hand clean 631-5.3.2	8	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Normal Fuel Oil Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	Tanks originally unpainted shall remain unpainted.
Oily Bilge Collecting Tanks	Near white blast	631-5.4.7.2	3 or 5	631-8.25.7	9.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	8	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Oily Drain Collecting Tanks	Near white blast	631-5.4.7.2	3 or 5	631-8.25.7	9.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	8	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Poppet Valve Drain	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Potable Water Tanks	Near white blast	631-5.4.7.2	6	631-8.25.7 and 631-8.8	8.0	Power tool clean 631-5.3.3	6	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	Surface to be completely clean and not polished. Only white and red MIL-P-24441 are interchangeable. Feathered edges.
Regulator Tank (SSN-576)	Near white blast	631-5.4.7.2	1	631-8.25.7	13.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	1	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Reserve Feedwater Inner Bottom Tank	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Reserve Feedwater Tank	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Safety Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Sanitary Flushing Tank, Wastewater Transfer Tank (SSN 575)	Near white blast	631-5.4.7.2	4	631-8.25.7	10.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	4	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Sanitary Tanks	Near white blast	631-5.4.7.2	4	631-8.25.7	10.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	4	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Seawater Expansion Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Steam Plant Surge Tanks	Near white blast	631-5.4.7.2	9	631-8.25.7	4.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	9	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Torpedo Impulse Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Torpedo Tube Drain Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Trim Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Variable Fuel Oil Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Waste Lubricating Oil Tanks (SSN 594, 637 Class)	Near white blast	631-5.4.7.2	2	631-8.25.7	9.0	Power tool clean 631-5.3.3 or hand clean 631-5.3.2	8	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Waste Oil Collecting Tank (SSN-575, 578 Class, 585/588 Class, SSN-688, SSN671); SSBNs	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Water Round Torpedo Tanks	Near white blast	631-5.4.7.2	2	631-8.25.7	8.0	Near white blast 631-5.4.7.2 or power tool clean 631-5.3.3	2	631-2.2.12 631-2.5 631-2.4.1.4 See Section 2	
Surfaces subject to exposure to MIL-S-19457 hydraulic fluid	Near white blast	631-5.4.7.2	1) 2 or 2) 3	631-8.21	1) 9.0 or 2) 8.0	Degrease, solvent wipe, hand clean 631-5.3.2	1) 2 or 2) 3	631-2.2.12 631-2.5 See Section 2	Surface to be completely clean and not polished. Feather edges.
Ferrous machinery surfaces (unheated, external and internal)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	1) 10 or 2) 11	631-8.10	1) 4.5 or 2) 4.5	Hand clean 631-5.3.2 or power tool clean 631-5.3.3	1) 10 or 2) 11	631-2.2.12 631-2.4.1.2 631-2.4.1.3 631-2.5 See Section 2	

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Ferrous sheet metal surfaces (unheated, external and internal)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	11	631-8.10	4.5	Hand clean 631-5.3.2 or power tool clean 631-5.3.3	11	631-2.2.12 631-2.4.1.2 631-2.4.1.3 631-2.5 See Section 2	
Ferrous sheet metal surfaces (heated, external and internal)	Near white blast or power tool clean (White metal if WSA)	631-5.4.7.2 or 631-5.3.3	12	631-8.10	1.0	Hand Cleaning or power tool clean 631-5.3.2 631-5.3.3	12	631-2.2.12 631-2.2.15.3 631-2.5 631-2.2.15.2.3 See Section 2	Unless wire sprayed aluminum is specified. See section 2 for carbon monoxide (CO) monitoring.
Ferrous machinery surfaces (heated, external and interior)	Near white blast or power tool clean (White metal if WSA)	631-5.4.7.2 or 631-5.3.3	12	631-8.10	1.0	Hand Cleaning or power tool clean 631-5.3.2 631-5.3.3	12	631-2.2.12 631-2.2.15.3 631-2.5 631-2.2.15.2.3 See Section 2	Unless WSA is specified, see section 2 or carbon monoxide monitoring.
Machinery gage boards (including gages and clocks)	Power tool or hand clean	631-5.3.2 or 631-5.3.3	13	631-8.10	4.5	Hand cleaning 631-5.3.2	13	631-2.2.12 631-2.4.1.2 631-2.4.1.3 631-2.5 See Section 2	
Thermally insulated machinery, valves, and piping	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	14	631-8.10	1.0 plus 1.5 finished	Hand cleaning 631-5.3.2	14	631-2.2.12 631-2.2.15.3 631-2.2.12 See Section 2	See section 2 for carbon monoxide monitoring.

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Gasoline piping and valves (exterior)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	15	631-8.10	3.0	Hand clean or power tool clean 631-5.3.2 or 631-5.3.3	15	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
Oxygen piping and valves (exterior)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	15	631-8.10	3.0	Hand clean or power tool clean 631-5.3.2 or 631-5.3.3	15	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
JP-5 piping and valves (exterior)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	11	631-8.10	4.5	Hand clean or power tool clean 631-5.3.2 or 631-5.3.3	11	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
Piping, fittings, and valves (galvanized and ungalvanized steel, and aluminum)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	11	631-8.10	4.5	Hand clean 631-5.3.2	11	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	Hand cleaning only allowed on 08 Cog. piping.
Nonferrous and corrosion resistant steel piping and valves, nonimmersion areas	Unpainted		Unpainted			None	None		Hand cleaning only allowed on 08 Cog. piping.

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Nonferrous and corrosion resistant steel piping and valves, immersion areas			Paint together with surrounding immersion areas						Hand cleaning only allowed on 08 Cog. piping. These surfaces in propulsion spaces of nuclear powered ships shall be left unpainted.
Electric and electronic equipment (except as otherwise indicated)	Hand clean or power tool clean	631-5.3.2 or 631-5.3.3	13	631-8.11	4.5	Hand clean 631-5.3.2	13	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
Motors and Generators (Exterior)	Hand clean or power tool clean	631-5.3.2 or 631-5.3.3	13	631-8.12.1	4.5	Hand clean 631-5.3.2	13	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	Except shafts and identification plate.
Motors and Generators (Interior)			15	631-8.12.2			See 631-8.12.2		
Electric Cables									See 631-8.14.
Metal Enclosures (Galvanized)	Hand clean or power tool clean	631-5.3.2 or 631-5.3.3	16	631-8.15	5	Hand clean 631-5.3.2	16	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Metal Enclosures (Bare Steel)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	17	631-8.15	5	Hand clean 631-5.3.2	17	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
Metal Enclosures (Aluminum)	Hand clean or power tool clean	631-5.3.2 or 631-5.3.3	11	631-8.15	5	Hand clean 631-5.3.2	11	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
Metal Enclosures (Miscellaneous Metals)	Hand clean or power tool clean	631-5.3.2 or 631-5.3.3	11	631-8.15	5	Hand clean 631-5.3.2	11	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	Brass, CRES, and nonferrous metals other than aluminum are not coated, except when required for appearance or camouflage.
Interior Communication and Fire Control Equipment			MIL-I-983 MIL-E-16400 MIL-E-18870	631-8.16		Hand clean 631-5.3.2	Same as metal enclosures	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
Lighting Systems	See 631-8.17						See 631-8.17		Do not paint light-reflecting and light-transmitting surfaces.

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Electronic Equipment	See 631-8.19	631-8.19		631-8.19		Hand clean 631-5.3.2			
Bilge Keels Rudder Internals (Internal Surfaces)			7	Table 631-8-9	Heavy Coat		7	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	Rudders may be filled and drained or float coated.
Furniture and Joiner Doors	MIL-F-902			Table 631-8-9			631-8.21		
Helmets	Hand clean	631-5.3.2	18	Table 631-8-9	4.5		631-8.21		Helmets should be recoated rather than touched up.
Inaccessible Surfaces (Galvanized and Non-ferrous)	Unpainted		Unpainted	Table 631-8-9		Unpainted			
Inaccessible Surfaces (Ungalvanized Steel)	Near white blast	631-5.4.7.2	19	Table 631-8-9	3.0	Near white blasts 631-5.4.7.2 or Power tool clean and needle gun 631-5.3.3	19	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	Touch-up surface must be equivalent in cleanliness to near white blast and have an anchor pattern.

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Structure Behind Insulation	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	20	Table 631-8-9	5.0	Hand clean 631-5.3.2 or Power tool clean 631-5.3.3	20	631-2.4.1.2 631-2.4.1.3 631-2.5 631-2.2.12 See Section 2	
Ventilation Ducts and Trunks	Near white blast	631-5.4.7.2	1) 2 or 2) 21 or 3) 22	Table 631-8-9	1) 9.0 or 2) 10.5 or 3) --	Hand clean 631-5.3.2 or Power tool clean 631-5.3.3	1) 2 or 2) 21 or 3) 22	631-2.2.12 631-2.5 See Section 2	Touch-up system (3) only with system (3), and system (25) only with system (25).
Seamless Coating for Small Objects	See 631-7.5 to 631-7.5.6.1		See 631- 7.5 to 631-7.5.6.1		See 631-7.5.2		See 631-7.5.6		Refer to 631-7.5 through 631-7.5.6.1
Turntable Pits (LSTs)	Near white blast	631-5.4.7.2	3	Table 631-8-9	8.0	Degrease, solvent wipe, hand clean 631-5.3.2	3	631-2.2.12 631-2.5 See Section 2	Surfaces to be completely clean and not polished. Feather edges.
Interior Bulkheads ** and Overheads	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	23	631-8.25.2	4.5	Commercial blast 631-5.4.7.2, power tool clean 631-5.3.3 or hand clean 631-5.3.2	23	631-2.2.12 631-2.5 631-2.2.9.3 See Section 2	Use only F-84 on aluminum. Water-base coatings approved for some applications.

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Painting Behind Equipment (Interior)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	24	631-8.23.7	3.0	Power tool clean 631-5.3.3 or hand clean 631-5.3.2	24	631-2.2.12 631-2.5 631-2.2.9.3 See Section 2	
Items Not Painted	See 631-8.22.1		See 631-8.22.1						631-8.22.1 is a list of shipboard items not to be painted.
Interior Decks and Walking Surfaces	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	25	631-8.25.2	4.5	Commercial blast 631-5.4.7.3, power tool clean 631-5.3.3 or hand clean 631-5.3.2	25	631-2.2.12 631-2.5 631-2.2.9.3 See Section 2	Use only F-84 on aluminum. Also see 631-8.23.6.1.
Fire Zone Bulkheads	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	26	631-8.23.5	12.0	Near white blast 631-5.4.7.2 or Power tool clean 631-5.3.3	26	631-2.2.12 631-2.5 See Section 2	

Table 631-1-5 SUMMARY OF COATING REQUIREMENTS FOR SUBMARINES-INTERIOR - Continued

Area or Compartment to be Finished	Initial or Overhaul Surface Preparation	NSTM 631 Para.	Initial or Overhaul Coating System*	NSTM 631 Para.	Minimum Dry Film Thickness of System (Mils)	Minimum Spot Repair Surface Preparation	Spot Repair Coating System*	Safety Precautions	Remarks
Wet Spaces (Wash-rooms, water closets, bath and shower spaces, sculleries, vegetable preparation spaces)	Near white blast or power tool clean	631-5.4.7.2 or 631-5.3.3	2	631-8.25.2	8.0	Power tool clean 631-5.3.3 or hand clean 631-5.3.2	2	631-2.2.12 631-2.5 See Section 2	Unless wire sprayed aluminum has been specified.

*Coating Systems:

NOTE

Except for potable water tanks and feedwater tanks, MIL-P-24441 epoxy paints may be applied as either a Type III three coat system (i.e., 150/151/152) or as a Type IV two coat system (i.e., 150/151 or 150/152) or where any Type III, MIL-P-24441 paint is specified, the equivalent Type IV MIL-P-24441 coating may be substituted. Unless otherwise stated in this technical manual or specified in work orders, total dry film thickness of the two coat Type IV system is to be the same as the thickness of the three coat Type III system. Potable water tank coating systems and application remain unchanged (see paragraphs 631-8.8 and 631-8.9).

SECTION 2.

SAFETY INFORMATION

631-2.1 GENERAL

631-2.1.1 This section contains safety precautions for all aspects of paint handling and operations except stowage. Stowage safety precautions are contained in **NSTM Chapter 670, Stowage, Handling and Disposal of Hazardous General Use Consumables** and in NAVSUPPUB on **Consolidated Hazardous Item List (CHIL)**.

631-2.1.1.1 The Occupational Safety and Health Act of 1970 established regulations and standards which govern occupational safety and health (OSH) matters. Executive Order 12196 provides guidance to the Department of Defense concerning OSH matters. DOD OSH Program Instruction (DODINST 6055.1) and Navy Occupational Safety and Health (NAVOSH) Program Manual (OPNAVINST 5100.19 Series/OPNAVINST 5100.23 Series) provide overall guidance. OPNAVINST 4110.2 Series establishes a uniform policy, guidance and requirements for life cycle control and total quality management of hazardous material acquired and used by the Navy.

631-2.1.1.2 Information in this section provides policy and the minimum requirements for safety and health aspects of paint handling, surface preparation and paint application. It cannot cover all conceivable operations and conditions. All personnel involved must understand the intent so that unusual circumstances are treated appropriately to protect personnel.

631-2.1.1.3 Personnel shall be adequately informed of and understand hazardous material hazards and the necessary protective measures (by way of hazard communication training), proper disposal techniques and procedures, and access to Material Safety Data Sheets (MSDSs) per OPNAVINST 5100.19 Series and OPNAVINST 5100.23 Series.

631-2.2 PAINTING OPERATIONS

631-2.2.1 GENERAL. The two most important factors with regard to a safe painting operation concern responsibility and training. Their importance shall be firmly established and clearly understood by all supervisors and personnel handling or applying any materials. At the level of actual operations, line supervisors are responsible

for all operations, and gas-test and safety personnel are responsible for providing staff assistance to the line supervisors. The responsibility factor is also particularly important at those supervisory levels where painting work is coordinated with other types of work.

631-2.2.1.1 Commensurate with their responsibilities and participation, all personnel connected with these operations shall be made aware of the hazards associated with the handling and use of hazardous and/or flammable materials, as well as the appropriate safety precautions. This information shall be a part of each individual's job training.

631-2.2.2 SUPERVISORY RESPONSIBILITIES. The supervisor shall lay out the work and manage projects in such a manner as to produce the safest possible conditions. Personnel safety is the supervisor's prime responsibility. A safety checklist shall be used before a job gets underway. In addition, all supervisors shall adhere to the following program:

- a. Always be aware of potential hazards in the area.
- b. Be sure that each painter understands and accepts personal responsibility for safety and is informed of all safety rules.
- c. Be sure that all safety measures have been taken before each work shift begins.
- d. Insist that crew-members work safely. Use disciplinary action in accordance with existing personnel directives, if necessary.
- e. Be sure that all equipment meets safety standards. Use non-sparking tools in fire-hazardous areas. Anticipate possible risks with new types of equipment. Secure expert advice on potential hazards in advance.
- f. Encourage personnel to discuss the hazards in their work. No job shall proceed if any question about safety remains unanswered. Be receptive to their ideas and suggestions. Their field experience can be a source of information that will help prevent accidents.
- g. Set a good example for the crew by demonstrating safety awareness in personal work habits.

631-2.2.2.1 The following is an example of a supervisor's safety checklist:

1. **NO SMOKING** signs posted.
2. Warning tags and signs posted.
3. Required protective clothing, safety shoes, and hard hat.
4. Required eye protection available as needed.
5. Required respiratory protection available as needed.
6. Buddy system setup if warranted.
7. Safety belts, harnesses, and tending lines on hand as required.
8. Toxic material control as needed.
9. Burn hazards (chemical, hot pipes, other).
10. Falling objects.
11. Moving objects, cranes, and other traffic considered.

12. Locations of safety showers and eye baths.
13. Location of fire alarm station.
14. Fire extinguishers and fire blankets on hand as required.
15. Location of nearest telephone.
16. Barricades as necessary.
17. Electrical hazards in vicinity taken into account.
18. Working electrical equipment grounded.
19. Sparkproof tools as required.
20. Flammability or flashpoints of painting materials and nearby stowed materials.
21. Safety and fire permits secured.
22. Gas Free Engineer's approval obtained.
23. Condition of ladders and scaffolding checked.
24. Safe footing provided for personnel.
25. Adequate ventilation.
26. Fire retardant masking paper.
27. The written safety precautions for abrasive blasting, hydro-blasting, power tools, and pneumatic tools in accordance with paragraphs [631-2.8.1](#) through [631-2.8.6](#).
28. Each worker shall be required to review and be familiar with potential health hazards and precautions for the materials involved in each operations. The DOD Hazardous Material Information System (HMIS), and Ships Hazardous Material List (SHML) provide guidance in this regard.
29. Adhere to guidelines in NEHC TM 92-2.

631-2.2.3 GENERAL PAINTING HAZARDS. Every painting operation exposes maintenance personnel and others in the area to conditions and situations that are potentially hazardous. Use of toxic and flammable materials, pressurized equipment, ladders, scaffolding, and rigging presents potential hazards. Hazards may also be inherent in working conditions or be caused by operator inexperience, lack of training, or carelessness. Awareness of all potential hazards is therefore essential because continuous and automatic observance of precautionary measures will minimize the danger and improve painting crew efficiency and morale. The degree of hazard along with the required control measures should be addressed on a case by case basis using MSDS's or product labels as reference sources. These references should be reviewed by each worker prior to the start of any operation. The following areas require alertness when painting operations are planned and executed:

- a. Paint materials
- b. Surface preparation materials
- c. Equipment
- d. Work Environment
- e. Painting crew
- f. Degree of hazard.

631-2.2.3.1 Paint Materials. Most paint materials are hazardous to some degree. All except water-based paints are flammable, many are toxic, and others can irritate the skin, eyes, and mucous membranes. All paints may be potentially hazardous based on their specific chemical composition and manner of use.

631-2.2.3.2 Surface Preparation Materials. Preparing a surface for painting often requires the use of solvents, acids, or alkaline cleaners (See paragraphs 631-2.8.7 through 631-2.8.8.6). All of these will irritate the skin, eyes, and mucus membranes unless used with care. Some paint removers are highly toxic. The use of high-pressure abrasive or water blasting methods can be hazardous. Pressures as low as 10 to 15 lb/in² have been known to cause serious injuries. In addition, continued exposure without respiratory protection during abrasive blasting operations may result in lung disease. Steam cleaning procedures employ both high heat and pressure that, if not properly handled, can cause serious burns and other injuries to the operator and nearby personnel.

631-2.2.3.3 Equipment. Ladders, scaffolding, and rigging shall be used for areas not readily accessible from the deck, pier, or dock. Pressure equipment is often used to prepare surfaces and to apply paint. All of this equipment can be hazardous if handled carelessly. More time may be required for proper equipment setup, dismantling and cleaning, required safety checks, and observance of basic equipment precautions than is required to prepare the surface or apply the protective coating. Nevertheless, precautions must never be omitted.

631-2.2.3.4 Work Environment. Working conditions will vary from job to job. In addition to the hazards inherent in the painting operation, the painter may encounter other hazards in the work area itself. For example, slippery decks or obstacles located on deck may cause falls; electrical or mechanical equipment may produce shocks or other serious injuries; uninsulated steam lines or hot pipes may cause severe burns, fire hazards, or too rapid evaporation of solvent, thus creating a toxic atmosphere.

631-2.2.3.5 Painting Crew. Lack of training, experience, or knowledge of hazards on the part of any painter produces a possible threat to the safety of the ship, painting crew, and others in the painting area. Carelessness of any painter will also increase hazards. Shortcuts often produce unsafe working conditions resulting in accidents, personnel injuries, and loss of time and materials. Observance of all safety precautions at all times will reduce this risk to a minimum.

631-2.2.3.6 Degree of Hazard. Each supervisor is responsible for ensuring that all necessary precautions are taken, designating the equipment required, and advising the crew of the specific hazards of each job. Ignoring these hazards will increase the odds that accidents will occur. Relaxing precautions in one job will inevitably lead to carelessness in subsequent jobs, regardless of the degree of hazard. The eventual result will be an increase in accident rates.

631-2.2.4 GENERAL SAFETY MEASURES. Potential hazards that exist in all painting operations make a continuing and enforced safety program essential. A good safety program that has adequate safety procedures will provide protection against the three major types of hazards: accidents, fire, and toxicity. All personnel shall observe all established precautionary measures and safety rules, and shall be thoroughly familiar with the safety measures described in the following paragraphs.

631-2.2.4.1 General Health. Guidance on assignments for painters who are sensitive to toxic or skin-irritating materials shall be obtained from an industrial hygienist. Only personnel not sensitive to heights shall work on ladders, scaffolding, or rigging. Painting crews shall be composed of personnel who have a proper attitude toward safety and who are in good physical condition.

631-2.2.4.2 Work Environment. Potential hazards in the work environment shall be considered before painters are sent into any work area: Hazards such as poor ventilation, noxious fumes, high or low temperatures, types of material and how they are applied, and the space where the work is to be done shall be considered. Before painters are allowed to enter the working area, they shall be protected by devices that will allow them to work in safety. Special action is required if any of the following conditions exist:

- a. If oxygen concentration is less than 20 percent;
- b. If combustible gas meter readings show differences between the work space and outside air; and
- c. If it is impractical, with available equipment, to test the workspace atmosphere for known or suspected toxic vapors or gases (such as bilge gases, distillate fuels, kerosene, or Navy standard fuel oil).

631-2.2.4.3 Ventilation. If ventilation is required, the basic ventilation objectives of NSTM S9086-CH-STM-030/CH-074 shall be followed. If such ventilation is not possible or ineffective, respiratory protective equipment shall be provided in accordance with the workspace conditions following the requirements of OPNAVINST 5100.19 Series.

631-2.2.4.4 Exhaust Systems. When exhaust systems are used, the system shall remove vapors or gases from the space or bottom of the tank or area in which work is being done, as well as potentially stagnant areas in accordance with S9086-CH-STM-030/CH-074. The hazard potential of stagnant areas and pockets shall be recognized. A crew-member shall never work alone in a hazardous area (see paragraph 631-2.2.4.10). Exhaust system discharges shall be arranged so that the contaminated air will not create health hazards in surrounding areas.

631-2.2.4.5 Temperatures. Temperatures in the work environment should be kept at 18 to 24°C (65 to 75°F), if practical.

631-2.2.4.6 Respiratory Protection. Select respiratory devices by the following criteria:

1. Only NIOSH-approved respiratory protective equipment shall be utilized. Such equipment shall be utilized only for the purpose and exposures for which the equipment has been tested and approved. A seal of approval is placed on an approved equipment.
2. All exposures or potential exposures must be carefully evaluated before proper respiratory protective devices can be selected. Such evaluation shall include, at a minimum:
 - a Types of contaminants present or likely to be present or generated (mists, fumes or vapors).
 - b Concentration of contaminants.
 - c Appropriate exposure limits of contaminants: threshold limit value (TLV), permissible exposure limits (PEL), threshold limit value ceiling (TLVC).
 - d Oxygen level.
 - e Atmosphere as a whole, i.e., whether or not space is Immediately Dangerous to Life or Health (IDLH).
3. Respiratory protective devices tested and approved by NIOSH (in accordance with the provisions of 30 CFR, Part 11) which includes the following:
 - a SCBA may be closed circuit, open circuit-demand or open pressure-demand types. These units are tested and approved for entry into or escape from atmospheres that are IDLH. Type C or CE supplied-air respirators, when equipped with a self-contained emergency air supply, if available, are also tested and approved for emergency entry into atmospheres that are IDLH.

- b Supplied-air respirators include hose masks with and without blowers, and airline respirators with respirable air supplied from a compressor or cylinder. These devices are tested and approved only for atmospheres that are not IDLH.
 - c Gas masks with canisters that remove specific contaminants such as ammonia from the in-drawn air are tested and approved for use in atmospheres that are not IDLH and that have sufficient oxygen to support life or for escape (only) from hazardous atmospheres.
 - d Cartridge or filter type respirators that remove contaminants such as dust, mist, fumes and vapors from in-drawn air are tested and approved for atmospheres that are not IDLH and that have sufficient oxygen to support life. These devices are capable of providing protection only against specific contaminants in limited concentrations. Therefore, take care to select the correct respirator and cartridge. Check the concentrations of contaminants to be sure they do not exceed the approved capacity of the device.
4. Pressure-demand respiratory devices are the most desirable for use in hazardous atmospheres. These units maintain a positive pressure within the facepiece at all times to minimize entry of airborne toxicants. Demand-only type devices, conversely, develop a positive pressure in the facepiece during exhalation and a negative pressure during inhalation. Therefore, if the facepiece is poorly fitted or sealed, toxicants may enter during the inhalation cycle.
5. The respiratory protection program, established under the requirements of OPNAVINST 5100.19 Series, NAVOSH Program Manual for Forces Afloat shall include gas free engineering personnel and operations and any other personnel and operations involved in entry or work in or on confined or enclosed spaces.

631-2.2.4.7 Respirator Care. Life or health may depend on availability and proper functioning of respiratory equipment. Equipment shall be cleaned immediately after use and shall be properly maintained and stored in clean, dry compartments. Filters, cartridges, and rubber parts shall be inspected before each use at regular intervals for any signs of deterioration. Any suspect filter or cartridge shall be replaced immediately. See OPNAVINST 5100.19.

631-2.2.4.8 Eye Protection. Safety glasses and safety goggles shall be worn in areas where there is a possibility of particulates, mists, or vapors entering eyes (for example, during blasting, sanding, or spraying operations). Eyewear should fit well, contain unbreakable glass or plastic lenses, should conform to ANSI standards for safety glasses (Z87.1-19), and should allow adequate peripheral and straight-ahead vision. Safety eyewear shall be kept clean and available. Crew-members working with chemicals shall wear chemical safety goggles. A full face respirator or ANSI-approved full length face shield may be necessary where protection of the eyes, face, and neck is required.

631-2.2.4.8.1 Emergency eyewash systems conforming to ANSI Z358.1-1990 must be immediately available near the work area should their use be required. Portable eyewash fountains must also conform to ANSI design criteria if permanently installed systems are not available.

631-2.2.4.9 Protective Clothing. Personnel shall wear adequate clean clothing and gloves to prevent skin contact with painting and cleaning materials. Clothing with cuffs, loose pockets or rips, and loose ties and jewelry shall not be worn since they are potential causes of hangups. The following precautions shall be adhered to with regard to protective clothing:

- a. NIOSH/MSHA-approved abrasive blasting respirators shall be worn during abrasive blasting;
- b. Hardhats and steel-toed safety shoes shall be worn wherever there is possible danger from falling objects;

- c. Nonskid, nonsparking, rubber-soled shoes shall be worn for work in enclosed spaces or where flammable vapors may be present (spark prevention);
- d. Acid-proof clothing shall be worn when handling acid or caustic cleaning; and
- e. Acid/caustic resistant suits with hood along with a full-face air supplied respirator shall be worn when using acid or caustic cleaning materials in enclosed spaces.

631-2.2.4.10 Buddy System. Personnel shall never work alone in hazardous areas. At least two crew members shall be assigned to such jobs, and each shall be in communication with the other at all times during operations in hazardous areas. If an accident occurs in a tank or other confined space, the crew member stationed on the outside must never enter the tank to give assistance alone, but shall seek help. Multiple deaths have occurred from failure to follow this basic precaution. Safety harnesses and tending lines shall be used in confined spaces. A supplied air respirator shall be available for each person working in a confined space. If the accident happens outside a confined space, the other crew member can seek help or come to the aid of the injured one. Based on the exposure of concern and the physical confines of the work space, a supplied air respirator may be required with an egress bottle.

631-2.2.5 INSPECTION SAFETY PRECAUTIONS. Safety precautions that shall be taken to ensure personnel safety during inspection of tanks, voids, and other hazardous areas to be painted are described in the following paragraphs.

631-2.2.5.1 Pre-Entry Requirements. Do not enter any enclosed or poorly ventilated space until a Gas Free Engineer has tested and certified that the space is safe for entry. For pre-entry requirements see **NSTM Chapter 074, Volume 3, Gas Free Engineering**. Station a crew member outside before entering any confined space such as tank or void.

631-2.2.5.2 Safety Equipment. Use necessary safety equipment. This may include hardhats, safety glasses, steel-toed rubber-soled footwear, gloves, coveralls, respirators, explosion-proof lights, safety harnesses, and life-jackets. Lifejackets shall be worn when working near or over water. Lifelines shall have no more than 2 feet of slack so that the jolt from a fall will not cause injury.

631-2.2.5.3 Personal Hygiene. Do not smoke, eat, or drink inside a tank or other hazardous area. Wash hands and face thoroughly before smoking, eating, drinking or using the toilet. Obtain medical attention immediately for inhalation irritation and for any cuts, abrasions or symptoms of ill health (dizziness) that are incurred during the inspection of these spaces.

631-2.2.6 SAFETY PRECAUTIONS FOR PAINT MIXING. Safety precautions to be observed in mixing areas at shore facilities and for forces afloat are specified in the following paragraphs.

631-2.2.6.1 Shore Facilities. The mixing area shall be adequately ventilated to prevent personnel overexposure to solvents and other toxic materials. If possible, detached shops or temporary structures shall be provided for paint mixing and for storing paint buckets, brushes, solvents, and rags. Permanent structures created for paint mixing and storage shall be equipped with automatic sprinklers. Signs reading NO SMOKING IN OR AROUND THIS BUILDING shall be posted conspicuously inside and outside each paint shop or other building in which paint is used, mixed, or stored. Only the quantity of solvent and paint needed for one workday shall be taken into the mixing area.

631-2.2.6.2 Forces Afloat. Paint shall not be stowed in the mixing area. For stowage requirements, refer to **NSTM Chapter 670, Stowage, Handling, and Disposal of Hazardous General Use Consumables**. Mixing of paints, varnishes, lacquers, and their solvents shall be confined to the paint mixing room or other designated compartments. Paint products shall not be mixed in a closed compartment without adequate ventilation. Posted barricades or other suitable measures shall be provided to ensure that there is no smoking, open flame, or hot work within mixing compartments or in adjacent passageways.

631-2.2.7 FIRE PREVENTION PRECAUTIONS FOR PAINT MIXING. Smoking, open flames (such as matches and torches), and hot work are prohibited in or near the area where paint, varnishes, lacquers, and their solvents are mixed, used or stored. Spilled paint or solvents shall be wiped up immediately to reduce fire and vapor hazards. Rags or other materials used for paint cleanup shall be placed in a closed-top metal container for disposal. Specific fire prevention precautions are described in the following paragraphs.

631-2.2.7.1 Electrical Equipment. In rooms where extensive paint mixing operations are carried on, electrical equipment shall be installed in accordance with Class I, Group D requirements of the National Electrical Code. Explosion-proof lamps with shatterproof lenses shall be used for lighting.

631-2.2.7.2 Firefighting. Authorized personnel, duty fire party, and damage control party using the mixing room shall be informed of the location and instructed in the use of the firefighting equipment and systems to be used on paint or paint-related fires. The firefighting equipment shall be readily accessible and escape routes from the area shall be prominently designated.

631-2.2.8 PAINT AND SOLVENT FLASHPOINTS. The definition of flashpoint is the lowest temperature at which vapors above a volatile combustible substance ignite in air when exposed to flame. Flashpoint is an indicator of a fire hazard; the lower the flashpoint, the greater the fire hazard. If doubt exists about the flashpoint of a paint or thinner, read the label on the material or check the vendor's data sheet or Material Safety Data Sheet (MSDS).

631-2.2.8.1 Low Flashpoint. Paints and solvents with flashpoints (closed-cup) less than 35°C (95°F) shall not be used for compartment and tank painting because of potential fire and explosion hazards. In exceptional situations when the use of substitute materials is unacceptable or the use of low flashpoint materials is required in confined spaces, ventilation rates shall be maintained to provide outside air at a minimum rate of 20 changes per hour. See S9086-CH-STM-030/CH-074 for further ventilation information.

631-2.2.8.2 Paint and Solvent Flashpoint Listing. Flashpoints of paints and solvents shall be determined by the Pensky-Martens closed-cup method, the Tag closed-cup method, or the Setaflash closed-cup method. Flashpoints of common solvents used in the paint are listed in [Table 631-2-1](#). The flashpoints of formulated paints generally parallel the flashpoints of the solvents used. However, many paints contain solvent blends and this cannot be used as an accurate gauge of flashpoint.

631-2.2.9 PERSONNEL PROTECTIVE PRECAUTIONS FOR PAINT MIXING. These precautions apply to paints in general. Skin contact, eye contact, ingestion, and breathing mists or vapors in excess of the Permissible Exposure Limit (PEL) or NAVOSH standard shall be avoided. A Navy Environmental and Preventive Medicine Unit (NAVENPVNTMEDU) or a local medical treatment facility (MTF) shall be consulted for direction if doubt exists concerning adequacy or acceptability of personnel protective procedures. The precautions necessary to protect personnel health and ensure safety during paint mixing are described in the following paragraphs.

631-2.2.9.1 Personnel Precautions. Personnel with a history of chronic skin disease, allergies, or asthma shall not be permitted to work with paint, paint materials, or thinners. Personnel who are sensitive to paint, paint materials, or thinners shall be reported to the medical department.

631-2.2.9.1.1 Persons handling paint materials shall avoid contact of material with skin and eyes, and inhalation of mists or vapors. No food, drink, or smoking materials shall be allowed in the paint area. When painting materials are handled, care shall be exercised to wash hands before eating, drinking, smoking, or using toilets.

631-2.2.9.2 Accidental Ignition. Extreme care shall be taken by persons mixing solvent-based paints to remove from their person all possible sources of ignition, such as matches, cigarette lighters, and steel buckles. Personnel shall wear nonskid, nonsparking, rubber-soled shoes (or canvas boots over their shoes) when working in an enclosed space or where flammable vapors may be present. Plastic clothing shall not be worn except when specifically approved by the safety department.

631-2.2.9.3 Alkyd and Oil-Base Paints. This category includes most interior compartment and passageway paints, as well as exterior enamel, silicone alkyd MIL-E-24635. Personnel mixing these paints shall wear eye protection and gloves during mixing operations. Personal respiratory protective equipment (NIOSH/MSHA-approved chemical cartridge or air line respirator) shall be required if airborne solvent vapor concentrations cannot be controlled by ventilation. Protective cream, in accordance with FED Spec. P-S-411, Type II (NSN 6580-00-244-4894), shall be used on exposed skin to act as a barrier, and for easier cleaning after painting. Skin that comes in contact with these paints shall be promptly cleaned with soap and water (not thinners).

631-2.2.9.4 Vinyl Paints. These include anti-fouling Formulas 121 and 129. Personnel mixing these paints shall wear protective garments that fit snugly at the ankles, neck, and wrists; and solvent-resistant synthetic rubber or plastic gloves and apron. NIOSH/MSHA-approved respiratory protection shall be required when air sampling data indicate solvent concentrations in excess of the exposure limit values, or when it is reasonable to assume that vapor concentrations cannot be controlled by ventilation and are expected to exceed the PEL or NAVOSH for the thinner involved.

631-2.2.9.5 Epoxy Paints. These include paints manufactured in accordance with MIL-P-24441 (Formulas 150 through 158), MIL-P-23236, as well as some approved proprietary epoxy paints which are used for coatings of tanks, bilges, wet spaces, and some exterior surfaces. Personnel mixing epoxy paints shall comply with the precautions given in the following paragraph.

Table 631-2-1 SOLVENT FLASHPOINTS

Solvent	Flashpoint (closed cup)	
	°C	°F
Amyl acetate	29	84
Butyl acetate	29	84
n-Butyl alcohol	35	95
Butyl carbitol (diethylene glycol monobutyl ether)	101	214
Butyl cellosolve (ethylene glycol monobutyl ether)	60	140
Carbitol (diethylene glycol monoethyl ether)	96	204
Cellosolve (ethylene glycol monoethyl ether)	42	108
Cellosolve acetate (ethylene glycol monoethyl ether acetate)	51	142

Table 631-2-1 SOLVENT FLASHPOINTS - Continued

Solvent	Flashpoint (closed cup)	
	°C	°F
Cyclohexanone	44	111
Diacetone alcohol	47	117
Ethyl alcohol	13	55
Super high-flash naphtha	43	110
Isobutyl acetate	18	64
Isobutyl alcohol	28	82
Isophorone	82	179
Isopropyl alcohol	12	53
Methyl n-butyl ketone	23	73
Methyl cellosolve (ethylene glycol monomethyl ether)	42	107
Methyl cellosolve acetate (ethylene glycol monomethyl ether acetate)	49	121
Methyl ethyl ketone	-1	30
Methyl isobutyl ketone	16	60
Mineral spirits (paint thinner)	43	109
SOLVATONE solvent M	26	78
Dry cleaning solvent, type II	59	138
Styrene	32	90
Toluene	4	40
Turpentine	35	95
VM&P naphtha	-7	20
Xylene	17	63

NOTE

Some of the above solvents have been identified as toxic/hazardous materials. Use shall be in accordance with all OSHA/NAVOSH precautions. Some have potential to be a reproductive hazard - that is adversely affect the human reproduction process.

631-2.2.9.5.1 Because of some ingredients used in epoxy paints, health hazards such as skin irritation and allergic reactions are greater than alkyds. If epoxy coatings contact the skin, prompt skin cleanup is mandatory. Soap and water, not solvents, shall be used, as solvent thin the paint and spread it over the skin, permitting greater penetration of paint into the skin, thus increasing the hazard of irritation or allergic reaction. Medical attention should be secured if skin reddening or rash appears.

631-2.2.9.6 Coal Tar Epoxy Paints. Coal tar epoxy paints are recognized as having cancer-causing properties and shall not be used.

631-2.2.9.7 Epoxy Thinners and Solvents. Epoxy thinners and solvents used in mixing paints contain ingredients such as ethylene glycol monoethyl ether that are readily absorbed into the body through the skin. Particular attention to skin protection is necessary to prevent skin absorption from adding significantly to overall exposure, especially during cleaning of equipment.

631-2.2.9.8 Polyurethane Coatings and Organotin Anti-fouling Paints. Precautions concerning the mixing and use of polyurethane coatings and organotin anti-fouling paints are described in paragraphs [631-2.6.2](#) through [631-2.7.13.4.1](#).

631-2.2.10 MEDICAL EVALUATION AND SURVEILLANCE. Each command is responsible for ensuring that all painters are referred to the medical department for placement in the medical surveillance program in accordance with the requirements of the OPNAVINST 5100.19 Series. Medical surveillance examinations shall be conducted in accordance with the requirements of the Medical Surveillance Procedures Manual and Medical Matrix (Edition 4) NEHC TM 91-5.

631-2.2.10.1 Personnel with signs or symptoms which may be caused by, or aggravated by, exposure to paint in the workplace shall be referred to the medical department for evaluation.

631-2.2.10.2 Showers provided in the shop shall be used by each work shift after spray painting. Also, personnel shall wash hands, arms, and face before eating, drinking, smoking, or using the toilet.

631-2.2.11 SAFETY PRECAUTIONS FOR PAINT APPLICATION. Safety precautions for paint mixing apply also to paint application. Additional application precautions are presented in paragraphs [631-2.2.11.1](#) through [631-2.2.16](#). Safety precautions applicable to shipboard paint spray booths are discussed in paragraphs [631-2.3.2](#) through [631-2.3.4.10](#).

631-2.2.11.1 Danger Area. For brush or roller painting operation, the local activity shall define and clearly delineate, by signs, those areas where there is a possibility of vapors which may pose a hazard to the painting personnel and operation. For spray application, the danger area shall extend a minimum of 25 feet from the painting operation. See paragraph [631-2.2.13](#).

631-2.2.11.2 Paint Application. Precautions to be observed when paints are applied by brush, roller, or spray are the same as those for mixing paints; in addition, for spraying the potential hazards from flammable or toxic solvents are greater. Additional ventilation in confined spaces is needed to comply with the requirements for flammable material control, see paragraphs [631-2.5.2](#) through [631-2.5.5.6.2](#). Depending upon location of the painting operation and type of paints used, respirators and protective clothing may also be needed to comply with personnel protective requirements.

631-2.2.11.3 Ignition Sources. Steps shall be taken to ensure the absence of ignition sources within the same area or compartment where paint is being applied. Prohibited activities include open flame or heat-producing work such as welding, cutting, or brazing and the energizing of nonexplosion-proof electrical circuits. Areas such as fire, engine, and pump rooms shall be in cold-iron condition before and during paint application. Spark or heat-producing work areas adjacent to where brush/roller application of paint is being performed may be considered outside the danger area provided that:

- a. The painting operation involves only minor (touch-up type) applications.
- b. The painting and hot work operations are separated by a watertight bulkhead.
- c. Either operation is not conducted on the adjacent (common) bulkhead.
- d. Naval shipyards are permitted to establish limits for specific hot work danger zones during painting operations, under the authority of the shipyard certified Gas Free Engineer (GFE) trained and qualified in accor-

dance with NAVSEA S6470-AA-SAF-010. These limits shall be based on the type of paint (flash point and volatility), method and amount of application, and the type and amount of hot work. Included in the requirements shall be provision for continuous monitoring of the atmosphere during the painting evolution; this may be accomplished by the use of automatic gas testing instruments set to alarm when the percentage of explosive vapors at the periphery of the established danger zone exceeds 5 percent of the Lower Explosive Limit (LEL). De-energizing of essential non-explosion proof electrical circuits would only be required if the level of explosive vapors/gases approached 10 percent of the LEL.

631-2.2.11.4 Highly Flammable Paints. Flashpoint labeling is a requirement for all paints and solvents. Personnel shall be instructed to read and understand container labels before using the paint product. Size of posted danger areas, amount of ventilation, and degree of other fire and explosion preventive procedures shall be increased and approved by a Gas Free Engineer prior to use of low-flashpoint paint materials.

631-2.2.11.5 Paint Flashpoints. Epoxy paints, in accordance with MIL-P-24441, and most interior or tank paints have a flashpoint of about 38°C (100°F). Commercial exterior epoxy paints and silicone alkyd surface ship topside enamel (MIL-E-24635) generally have flashpoints above 27° C (80°F). A few paints have lower flashpoints, some below 17°C (60°F), and present much greater fire and explosion hazards. These highly flammable paints include vinyl anti-fouling paints (Formulas 121 and 129) and some special-purpose paints such as heat-resistant aluminum paint (FED-Spec. TT-P-28). Paints made in accordance with FED Spec. TT-P-28 have varying flashpoints, depending upon the manufacturers. These flashpoints can be determined only by reading warning labels on the cans or by consulting the manufacturer's literature or Material Safety Data Sheet.

631-2.2.11.6 Vinyl and Epoxy Paints. Personnel applying these paints by brush or roller should avoid skin contact with the mixed paint and its components by wearing solvent resistant, synthetic rubber or plastic gloves, and apron. Sleeves shall be kept rolled down. A face shield or chemical safety goggles shall be worn to protect face and eyes. FED Spec. P-S-411, Type II Protective cream (NSN 6850-00-244- 4894) shall be used on exposed skin to act as a barrier, and for easier cleaning. Local exhaust or supply ventilation, or both, shall be used to control personnel exposure to solvent vapors to the best extent possible.

631-2.2.11.7 Nonskid Deck Coverings. Safety precautions for the application of nonskid deck coverings are presented in **NSTM Chapter 634, Deck Coverings** .

631-2.2.11.8 Paint Thinner Flashpoints. The most common shipboard paint thinner, FED Spec. TT-T-291, Type I, should be used for thinning or cleanup of alkyd and oil-based coatings. This thinner has a flashpoint above 38°C (100°F). Synthetic enamel thinner (FED-Spec. TT-T-306) has a flashpoint of 27°C (80°F) minimum and should be used for thinning or cleanup of heat-resistant aluminum paint (FED-Spec. TT-P-28). Choice of thinners for commercial proprietary coatings depends upon the recommendations. Flashpoints can be found in the manufacturer's literature or printed on the can labels.

631-2.2.11.9 Minimum Flashpoint Specifications. Only coating materials having flashpoints of 35°C (95°F) minimum shall be used in spray booths, with the exception of synthetic enamel thinner. Where material with flashpoints less than 35°C (95°F) are specified in drawings and equipment specifications, NAVSSES shall be consulted for assistance in determining whether less flammable alternatives exist or a waiver to this requirement should be requested.

631-2.2.12 APPLICATION OF PAINT IN CONFINED SPACE. Precautions that shall be observed when painting the interior surfaces of a confined space, such as the inside of a tank, are described in the following paragraphs.

631-2.2.12.1 Explosion-Proof Lamps. Explosion-proof lamps with shatterproof lenses, such as Crouse-Hinds Model RCDE-6 or RCDE-6 or equal, shall be installed. Lights shall be completely and properly assembled and in operable condition prior to installation in the danger area. Bulbs shall not be replaced nor lights repaired within the danger area. Portable lights shall be hung, using sparkproof hooks, and shall never be wrapped around nor draped over supports.

631-2.2.12.2 Gas Free Testing. Periodic tests shall be conducted to ensure safe, gas free working conditions. The Gas Free Engineer should conduct the initial test, with monitors conducting the follow-up tests under his supervision. During paint operations, gas testing shall continue as necessary to detect dangerous accumulations of hazardous vapors.

631-2.2.12.3 Ventilation. During paint operations, all tanks and enclosed areas shall be properly ventilated. If the vented paint vapors will create an explosion hazard outside the tank or compartment being painted, water curtains or precipitators shall be installed at the vents, and ventilation shall continue for at least 1 hour after the operation has been completed and until vapor concentrations remain below 10 percent of the Lower Explosive Limit (LEL). General brush and roller painting precautions listed in paragraphs [631-2.2.11](#) through [631-2.2.11.9](#), and applicable requirements included in **NSTM Chapter 074, Volume 3, Gas Free Engineering**, shall be observed.

631-2.2.13 APPLICATION BY SPRAY. The application of paints, varnishes, lacquers, enamels, and other flammable liquids by the spray process is more hazardous than brush application because of the volume of material which can be applied, and because spraying deposits a flammable residue which is subject to spontaneous ignition, see paragraph [631-2.3.4.8](#). Potentially harmful mists created by paint spraying operations add to health hazard. Precautions for paint spraying include those for mixing and paint application, as well as the requirements described in the following paragraphs.

631-2.2.13.1 Personnel Protective Precautions. Spray painting requires all the precautions of brush painting, with additional measures to protect personnel from airborne paint mist.

631-2.2.13.2 Fire Prevention Precautions. During spray painting, precautions in addition to those for brushing or mixing are necessary to prevent static sparking and excessive flammable solvent concentrations. Danger areas shall extend at least 25 feet from the painting operation and may include an entire dry dock in cases of extensive painting with highly flammable paints. Rope off and post DANGER AREA signs in the vicinity of the painting operation to alert personnel to the hazard. These signs shall designate the danger area and prohibit smoking, hot work, and open flame. All energized electrical circuits in the danger area shall be explosion-proof (Class I, Group D or better) and all equipments requiring grounding shall have a common ground. During spray painting operations, fire extinguishing equipment shall be in the ready condition.

631-2.2.13.3 Protective Clothing and Gear. Spray painters shall wear gloves and protective garments that fit snugly at ankles, neck and wrists. They shall wear approved respirators while spraying, mixing, or handling any materials which create flammable vapors. Spray gun mists shall never be inhaled.

631-2.2.13.4 Showers. If paint spraying operations are extensive, showers should be available and operators should shower after every shift.

631-2.2.13.5 Cleaning Spray Guns. Spray guns, paint containers, and hoses shall be thoroughly cleaned after use, but shall never be cleaned in confined areas.

631-2.2.13.6 Vinyl and Epoxy Paints. Personnel spray painting with epoxy paints, in accordance with MIL-P-24441, in other than approved spray booths shall wear coveralls, gloves and NIOSH-approved air line respirators which provide full-face coverage. The air supplied to the respirator shall meet specifications for breathing air. Exposed skin areas shall be covered with protective cream. The same precautions apply to application of vinyl paints, except that NIOSH-approved organic vapor respirators may be substituted for air line respirators when work is done in open exterior spaces. Approved goggles shall be worn except when eye protection is provided by air-supplied respirators or hoods. When these coatings are applied overhead or on surfaces above waist level of the workers, approved hoods which completely protect the head, face, and neck shall be worn. See OPNAVINST 5100.19 for breathing air specification.

631-2.2.14 EXPLOSION HAZARD IN SPRAY PAINTING EQUIPMENT CONTAINING ALUMINUM PARTS IN CONTACT WITH HALOGENATED HYDROCARBONS. The National Spray Equipment Manufacturer's Association has reported explosions involving high pressure fluid handling equipment. This investigation indicated that the explosions were caused by a violent reaction between aluminum and halogenated hydrocarbon solvents within the confined, pressure-coating sections of high pressure pumps or heaters. Severe corrosion in other fluid handling equipment has also been attributed to this reaction. Concern centers upon aluminum, zinc, or galvanized fluid handling equipment used for processing or application of paints, coatings, cleaning agents, adhesives, or other fluids containing halogenated hydrocarbons. This type of equipment includes pumps, heaters, filters, valves, spray guns, and pressure tanks. The hazard can be avoided by ensuring that halogenated hydrocarbon solvents are used only in compatible equipment. Suitable materials for compatible equipment include steel and stainless steel. Where doubt exists as to the presence of halogenated hydrocarbon solvents in any formulation, container labels, material safety data sheets, or the manufacturer should be consulted.

631-2.2.14.1 The chemical reaction associated with the hazard appears to involve a chemical process capable of progressing rapidly and producing enormous energy. The hazard involves more than the simple hydrostatic rupture of a pressurized component. The reaction is unpredictable. The reaction may proceed only to the point of causing corrosion, or it may continue and cause an explosion. Prior use of halogenated hydrocarbon solvents in aluminum-bearing equipment without incident does not mean such use is safe.

631-2.2.14.2 Chemical suppliers are adding inhibitors to their halogenated hydrocarbon solvents to prevent the reaction. However, these inhibitors may be rendered ineffective when combined with water or diluted by the addition of a traditional solvent to thin a compliant coating material, therefore, no known inhibitor will be effective under all circumstances.

631-2.2.14.3 If a halogenated hydrocarbon solvent has ever been used in equipment with aluminum or galvanized parts, the following procedure shall be followed:

1. Empty system, shut down all equipment, relieve pressure.
2. Disassemble all equipment, including pumps, heaters, spray guns, and pressure tanks and clean all parts with nonhalogenated solvent. (Equipment supplier may be consulted for cleaning solvent recommendations.)

3. Check all parts for corrosion and wear, replace damaged parts as necessary before reassembly.
4. Flush the entire system with nonhalogenated solvent.
5. Make certain that the equipment is not used with halogenated hydrocarbons in the future.

631-2.2.15 REQUIREMENTS FOR WHITE ENAMEL (FORMULA 30) AND CERTAIN HEAT-RESISTANT PAINTS IN ENCLOSED SPACES. Additional requirements and precautions are given in the following paragraphs for use of white enamel (Formula 30) (DOD-E-1115), and heat-resistant paint (FED-Spec. TT-P-28), in enclosed spaces on surface ships and submarines.

631-2.2.15.1 Specified Uses. On submarines and some surface ships, Formula 30 is specified, in non-deviation paint schedules, for painting surfaces such as bulkheads, overheads, components, piping, lagging, and vent ducts. On surface ships, Formula 30 is also specified for coating peak tanks. Heat-resistant paint is specified in various compartments and spaces for surfaces exposed to temperatures above 149°C (300°F) (unmanned spaces) and 52°C (125°F) (manned spaces).

631-2.2.15.2 Test Results. Air samples taken from an enclosed compartment on a submarine, after application of Formula 30 enamel, showed a high level of carbon monoxide (CO). As a result, CO-emission analyses of this enamel and a number of currently specified interior paint formulations were conducted by the David Taylor Research Center, Annapolis, MD. Test results of particular concern are delineated in the following paragraphs.

631-2.2.15.2.1 The general data for all paints tested indicated that CO levels increased with temperature and decreased with time. However, only testing can reveal whether the atmosphere is acceptable.

631-2.2.15.2.2 Although white enamel (DOD-E-1115) (Formula 30) and heat-resistant paint (FED-Spec. TT-P-28) are considered to be more of a problem since they are used for certain higher temperature applications, other paints may also give high levels of CO, if heated.

631-2.2.15.2.3 Monitoring Protection from Potentially Toxic Vapors. Acrolein vapor may be generated by the curing of the Formula 30 and Formula TT-P-28 paints when the system temperatures of painted surfaces (engine room, auxiliary machine room, etc.) are elevated during hot evolutions/operations (Hot-Ops).

631-2.2.15.2.4 Acrolein levels in each affected space should be monitored during high temperature evolutions. Monitoring results dictate fresh air ventilation (non-recirculated) and/or respiratory protection requirements. Ensure that the affected personnel are advised of the potential for an acrolein problem and that appropriate personnel are trained and medically qualified in accordance with OPNAVINST 5100.19 Series for respiratory protection. The appropriate respiratory protection for use by personnel who may enter the affected spaces during periods when acrolein levels may exceed the PEL:

Acrolein Level	Respirator
0.1 - 2.5 ppm	Full face air purifying with organic vapor cartridges or full face air supplied or air fed hood.
Greater than 2.5 ppm	Full face air supplied operated in pressure demand mode or self-contained breathing apparatus.

631-2.2.15.3 White Enamel (DOD-E-1115) (Formula 30). When subject to a temperature of 38°C (100°F) after a 1-day drying period, white enamel emitted CO in excess of the permissible exposure limit value (35 p/m)

established by the OSHA, and the 15 p/m 90-day exposure limit established for submarines. However, this level was not exceeded after a 10-day drying period. Although tests were not conducted at ambient temperatures of 24-27°C (75-80°F), it is expected that results would be similar. However, when white enamel was subjected to temperatures of 121°C (250°F) after a 10-day drying period, the levels still exceeded the 90-day limit.

631-2.2.15.4 Heat-Resistant Paint (FED-Spec. TT-P-28). At 121°C (250°F) and 204°C (400°F), heat-resistant aluminum paint (FED-Spec. TT-P-28) gave excessively high levels of CO, even after a 10-day drying period. This coating did not give high CO levels when tested at 38°C (100°F).

631-2.2.15.5 Ventilation and Entry Requirements. Compartments or spaces in which surfaces are painted with Formula 30 shall not be closed until ventilated for an adequate period. Periodic checks for CO levels will be made to determine whether the period of ventilation is adequate and compartments are safe for personnel entry. If an entire compartment is painted, ventilating for approximately 10 days may be required to obtain a safe level. If painting is minimal, the ventilation period may be reduced to 1 or 2 days, depending upon emission levels produced.

631-2.2.15.5.1 There are no other tested and approved alternative heat-resistant paints. Therefore, when these types of paints are used, the painted compartment shall be ventilated and CO emission levels tested, before and after surfaces are exposed to high temperatures. Heat-resistant aluminum paint may not give off high levels of CO until subjected to temperatures of 121°C (250°F) or higher. When systems painted with this formula (FED-Spec. TT-P-28) are later subjected to such temperature, the CO level shall be checked before compartments are entered.

631-2.2.15.6 Carbon Monoxide (CO) Monitoring. The CO shall be monitored following any painting operations in enclosed spaces to ensure that the air is acceptable. Additional tests, including flammability and oxygen level, shall be performed. A Gas Free Engineer or designated representative shall conduct tests for CO.

631-2.2.15.6.1 Formula 30 and heat resistant paint shall not be applied in interior spaces unless the requirements for ventilation and determining CO emission levels are carried out. Local painting instructions shall specify ventilation and monitoring requirements.

631-2.2.16 AIRLESS SPRAY SAFETY PRECAUTIONS. Personnel shall receive complete instructions in the proper use of airless spray equipment before being permitted to operate the equipment or to assist the operators. Training shall stress the potential dangers associated with handling of airless spray equipment, as well as the built-in safety features designed to minimize these dangers. The airless spray method uses a pump to deliver high-pressure fluid to the small, spray-tip orifice. This high-pressure (up to 4500 lb/in²) system is potentially hazardous. Amputations and deaths have resulted from careless use of this equipment, particularly when spray tips are removed for cleaning. Before a spray tip is removed or adjusted and when spray operations are shut down for an extended period, it is mandatory that electrical pumps be shut off, and that the gun trigger be depressed to bleed line pressure.

631-2.2.16.1 Painters using airless spray shall comply with the following precautions:

1. Do not use airless spray equipment unless fully trained.
2. Never allow an untrained person to use the equipment.
3. Never put hands or fingers in front of the spray gun.

4. Never point the gun at a person.
5. Never work on or repair pressurized equipment. The equipment shall be shut off, the pressure released, and the trigger safety engaged before disassembly. **SHUTTING OFF THE POWER DOES NOT RELEASE THE PRESSURE .**
6. Always secure connections to prevent leaks.
7. Never spray a flammable solvent through the gun tip; the high velocity generates static electricity which would cause a fire or explosion.
8. Before use, check hoses for leaks, cuts, and wear. Replace any damaged hose. Never plug hose leaks with fingers.
9. Wear protective gloves and goggles at all times.
10. Use the trigger lock at all times when not actually spray painting (for example, before wiping the tip). Remove the tip guard only if spraying with it in place is impossible.
11. Never leave pressurized airless spray unit unattended.
12. Always remove the gun from the hose after flushing and when storing.
13. The airless spray gun is a dangerous weapon. Keep the trigger safety engaged when not in use.
14. Obtain immediate medical attention for injuries. Report the nature of injury and the type of fluid or solvent being used.

631-2.3 PAINT SPRAY BOOTHS

631-2.3.1 GENERAL. A paint spray booth is a ventilated structure which provides an enclosed space for spraying operations. It confines and limits the escape of sprays, vapors, and residues and directs them safely to an exhaust system. Proper operation and maintenance of paint spray booth equipment is essential to avoid the risk of a potentially catastrophic fire.

631-2.3.2 SAFETY PRECAUTIONS. Two types of paint spray booths are installed aboard naval ships. These are the waterwash type and dry filter type. Both have open frontal access and are constructed of steel. Paint spray booths and their safety precautions are described in the following paragraphs.

631-2.3.2.1 Exhaust System. Each booth has its own independent exhaust system which is equipped with explosion-proof fan motors. For safe operation of these booths, the filtering medium shall be maintained. If paint spray is not filtered out, it will collect in the exhaust fan and ducting, creating a potential fire hazard. It is highly important that a minimum air velocity within the spray booth of 100 feet per minute be maintained. For very large walk-in booths, 75 feet per minute is recommended.

631-2.3.2.2 Filter System. In the dry filter booth, filter pads shall be replaced when examination indicates filters are paint-loaded. Visible gauges or pressure activated devices shall be installed to indicate or insure the required air velocity is maintained. In the waterwash booth, the baffle plates and nozzles shall be examined and stripped of paint as necessary. When the filters or baffles show evidence of paint-loading, further inspection of exhaust system is required, including the exhaust fan. For both types of paint spray booths where touch-up painting is involved, the filtering mechanisms shall be inspected for accumulation of paint residues every 3 months.

631-2.3.2.3 Waterwash Paint Spray Booth. The waterwash paint spray booth is equipped with a waterspray system that is designed to minimize residue entering the exhaust system. The system uses baffle plates and nozzles to maintain a waterspray curtain between the spray paint and exhaust system. It is important that the baffle plates and nozzles do not become covered or plugged with residue accumulations which will decrease the collection efficiency and create open areas in the waterspray curtain.

631-2.3.2.3.1 The waterwash system also permits the recovery of overspray finishing material in a settling tank. This tank is normally installed on the left-hand side of the booth and is equipped with horizontal and vertical screens to collect paint residue and sludge. Chemical additives are used in the water to precipitate the residues so that they may be skimmed off the water surface. Paint residue and sludge shall not be allowed to accumulate. As this material is highly flammable, it shall be promptly collected and stored in a closed metal container for proper disposal.

631-2.3.2.4 Dry Filter Paint Spray Booth. A typical dry filter paint spray booth is equipped with disposable dry filters to minimize residues entering the exhaust system. The filter area is approximately 40 inches by 40 inches and has 4 dry filters, each 20 inches by 20 inches. Should the dry filters become paint-loaded, spray paint may be forced back onto the operator and out from the booth.

631-2.3.2.5 Dry Filter Paint Booth Air Filter Gauge. The dry filter paint spray booth is equipped with a flex tube manometer which serves as an air filter gauge. Newly purchased spray booths are supplied with green and red stick-on markers which are arrowhead in shape. Follow the manufacturer's or the industrial hygienist's recommendation in the placement of these markers after acceptance testing of the booth.

631-2.3.2.6 Unauthorized Spray Booths. Forces afloat are cautioned against using spray booths of a type not corresponding to those described in paragraphs [631-2.3.2.1](#) through [631-2.3.2.5](#).

631-2.3.3 FLAMMABLE HAZARDS ASSOCIATED WITH PAINT SPRAY BOOTHS. Refer to paragraph [631-2.2.8](#) for detailed guidance related to paint flashpoints. Refer to paragraph [631-2.2.11.8](#) for detailed guidance related to paint thinner flashpoints.

631-2.3.4 PAINT SPRAY BOOTH OPERATION SAFETY PROCEDURES AND PRECAUTIONS. Safe operation of paint spray booth is described in the following paragraphs.

631-2.3.4.1 Physical Layout. No open flame, spark-producing equipment, incandescent lamps, nor electrical receptacles shall be used or installed in the space extending 10 feet horizontally from the open front of the spray booth and vertically from the deck to 3 feet above the top of the booth, unless the equipment is explosion-proof (Class I - Group P). For a graphic layout of the restricted space, refer to the National Electrical Code.

631-2.3.4.2 Portable Equipment Restrictions. The use of portable equipment is restricted during spraying operations, which include preparation of material, spraying, and the prescribed exhaust time.

631-2.3.4.3 Electrical Grounds. All metal parts of the spray booth, including exhaust ducts and spray, shall be electrically grounded.

631-2.3.4.4 Flammable Liquids. Only a one-day or one-shift supply of flammable liquids may be present in the booth when the booth is in use.

631-2.3.4.5 Drying Spaces. Drying spaces shall be adequately ventilated; otherwise they will be regulated as spraying areas.

631-2.3.4.6 Exhaust Fan. When paint spraying operations are completed, the exhaust fan should be run for at least an additional 3 minutes more to purge vapors from the booth.

631-2.3.4.7 Fire Extinguisher. An 18-pound portable PKP fire extinguisher shall be maintained within 5 feet of booth opening.

631-2.3.4.8 Lacquer Spraying. Booths used for spraying lacquers shall not be used for spraying other coatings unless thoroughly cleaned. Otherwise, the residue buildup of alternative deposits of lacquer and other paint or stain finishes may be subject to spontaneous heating. Also, booths shall not be used for hot-air drying of coated objects. Such use can increase booth surface temperature, adding to the spontaneous heating hazard.

631-2.3.4.9 Minimum Flashpoint Specifications. Refer to paragraph [631-2.2.11.9](#) for detailed guidance.

631-2.3.4.10 Heat Resistant Aluminum Paints. As approved in other sections of this chapter, heat-resistant aluminum paint shall be used in painting operations where heat-resistant aluminum paint (FED Spec. TT-P-28) has been specified.

631-2.4 PAINT AND SOLVENT HEALTH HAZARDS

631-2.4.1 PAINT COMPOSITION. Stock numbers and specification numbers for commonly used ship painting materials are covered in section 3. These specifications contain either a complete list of product ingredients or a generic description of the product, with performance requirements, which can be used to identify other complying products. Approved proprietary products and their manufacturers may be found on the Qualified Products List (QPL), if applicable, for each military and federal specification. For example, approved products in accordance with MIL-P-23236 may be found on QPL- 23236. OPNAVINST 5100.19 Series, regarding the furnishing of material safety data sheets by contractors and manufacturers of hazardous materials, shall be reviewed for additional information concerning material hazards and composition. Information concerning paint composition can also be requested from manufacturers or from NAVSSES. Due to the performance oriented nature of many paint systems, the chemical nature of each paint cited should be reviewed and verified.

631-2.4.1.1 General. A NAVENPVNTMEDU or a local medical treatment facility shall be consulted for guidance in acceptability and adequacy of personnel protective procedures for specific materials.

631-2.4.1.2 Alkyd and Oil-Base Paints and Varnishes. These include Formulas 30, 34, 84, 109, 111, 124, 125, 126, and coatings in accordance with FED Specs. TT-V-51, TT-E-439, TT-E-489, TT-E-490, DOD- P-21035 and MIL-E-24635. These contain hydrocarbon solvents such as paint thinner (FED Spec. TT-T-291) and vegetable oil resins which include glyceryl phthalate (alkyd) resin (FED Spec. TT-R-266).

631-2.4.1.3 Vinyl Paints. These include Formulas 121 and 129. They contain vinyl resins and solvents such as methyl isobutyl ketone and xylene.

631-2.4.1.4 Epoxy Paints and Hull Repair Compounds. These include MIL-P-24441, MIL-C-22750, MIL-P-23236, some NAVSEA approved proprietary paints, and MIL-C-24176 Hull Repair Compounds. These contain

epoxy resins and amine, polyamine, or polyamide curing agents. Paints in accordance with MIL-P-24441 contain n-butyl alcohol (butanol) and naphtha. Butanol and naphtha are often used for thinning paint and cleaning equipment. The commercial epoxy paints are proprietary products which may contain the above solvents, as well as ketones, esters (for example, butyl acetate), and aromatic or aliphatic hydrocarbons (for example, xylene or paint thinner).

631-2.4.1.5 Coal Tar Epoxy Paints. Coal tar epoxy paints are recognized as having carcinogenic (cancer-causing) properties and shall not be used.

631-2.4.1.6 Organotin Materials. Organotin materials contain anti-fouling agents, such as bistributyltin oxide (TBTO) or tributyltin fluoride, that are toxic to the skin, eyes, and respiratory tract (see paragraph [631-2.7.2](#)).

631-2.4.2 HAZARDOUS PAINT INGREDIENTS. The DoD and the Navy have adopted the OSHA standards for use throughout the agency. However, provisions for alternates or supplemental standards or other special standards exist and are addressed in OPNAVINST 5100.23 Series, Chapter 16.

- a. Personnel exposure to the specifically listed airborne contaminants shall not exceed the Time Weighted Average (TWA), Short Term Exposure Limits (STEL) and/or Ceiling limits. These are called Permissible Exposure Limits (PEL) specific for that substance. The TWA is the employee's average airborne exposure in any eight hour work shift of a 40 hour workweek, which shall not be exceeded. The ceiling is the worker's exposure, which shall not be exceeded during any part of the work day. If instantaneous monitoring is not feasible, then the ceiling shall be assessed as a 15 minute TWA exposure, which shall not be exceeded at any time over a working day.
- b. The Threshold Limit Value (TLV_{ae}) is established by a committee of the American Conference of Governmental Industrial Hygienists (ACGIH). These values are reviewed on a routine basis and are considered a consensus standard.
- c. The "skin" designation indicates that the contaminant shall be prevented or reduced to the extent necessary by gloves, coveralls or other appropriate PPE/engineering controls to reduce skin absorption.
- d. A workplace assessment, as conducted by an industrial hygienist or by a qualified industrial hygiene technician, is necessary to assist in making recommendations regarding the protection of personnel.
- e. Training must provide personnel with sufficient knowledge for the effective participation in the OSH program, as required by OPNAVINST 5100.9 Series. Specific hazards and safe work practices for the hazardous materials/chemicals they use in the workplace must be addressed.
- f. Specific precautions related to hazardous paint ingredients are described in the MSDS or HMIS for the paint in use along with guidance with regard to potential health hazards related to working with a specific coating.

631-2.4.2.1 N-Butyl Alcohol. Exposure to vapors produces irritation to nose, throat, and eyes. The TLV (ACGIH) is 50 p/m. Butyl alcohol also causes contact dermatitis.

631-2.4.2.2 Cresol. This is a strong irritant which frequently causes dermatitis. Serious or even fatal poisoning may result if large areas of the skin are wet with cresol unless it is removed immediately. The TLV (ACGIH) for cresol (all isomers) is 5 p/m.

631-2.4.2.3 Dichloromethane. This is a volatile solvent, mildly irritating to the skin. Inhalation of its vapors can produce drunkenness and narcosis. The TLV (ACGIH) for dichloromethane is 200 p/m.

631-2.4.2.4 Epoxy Resin (Uncured). This is a primary skin irritant and possible skin sensitizer. Exposure to epoxy resins in the uncured form shall be minimized.

631-2.4.2.5 Ethylene Glycol Monobutyl Ether. This chemical is moderately toxic if taken orally. It is irritating and injurious to the eyes, but is not significantly irritating to the skin. It is readily absorbed through the skin and toxic if inhaled. The TLV (ACGIH) for ethylene glycol monobutyl ether is 25 p/m. The low volatility of ethylene glycol monobutyl ether at room temperature considerably reduces the hazard of toxicity from inhalation. Skin absorption through direct contact with the liquid can add significantly to overall exposure and must be prevented.

631-2.4.2.6 Ethylene Glycol Monoethyl Ether. This chemical is low in oral toxicity and is not significantly irritating to skin. However, it is readily absorbed through the skin. Airborne concentrations high enough to produce toxic effects by inhalation have a disagreeable odor and irritate the eyes. The recommended TLV (ACGIH) is 5 p/m calculated as a time-week. Skin absorption, if not prevented, can add significantly to overall exposure.

631-2.4.2.7 Formic Acid. This acid produces severe primary damage to skin, eyes, and mucous membranes. It is suspected that the presence of formic acid in paint remover could, through destruction of skin tissue, accelerate the absorption of phenol, cresol, and their toxic components.

631-2.4.2.8 Methyl Ethyl Ketone. This chemical can irritate eyes and mucous membranes. Repeated skin contact with the liquid may cause skin dryness and irritation. Exposure to vapor levels about 200 p/m TLV (ACGIH) may cause narcotic effects.

631-2.4.2.9 Methyl Isobutyl Ketone. Effects of this chemical are the same as those for methyl ethyl ketone, except that the TLV (ACGIH) is 100 p/m (50 p/m proposed).

631-2.4.2.10 Methyl Normal Butyl Ketone. Effects of this chemical are the same as those for methyl ethyl ketone, except that it can also cause nervous system damage. Its TLV (ACGIH) is 5 p/m. An industrial hygienist, NAVENPVNTMEDU, or NRMCO Occupational Health Service, shall be consulted before using methyl normal butyl ketone.

631-2.4.2.11 Paint Thinner, FED Spec. TT-T-291, Type II, Grade A, Boiling Range 150-210°C (302-410°F). Paint thinner vapors are mildly irritating to mucous membranes. Repeated or prolonged skin contact with paint thinner will dry and defat the skin, resulting in irritation and dermatitis. The TLV (ACGIH) for Stoddard Solvent, which is comparable to Type II, Grade A, is 100 p/m.

631-2.4.2.12 Phenol. This hazardous chemical is highly toxic when ingested, inhaled, or absorbed through the skin. It is readily absorbed through intact skin. Death has been reported to result from absorption of phenol through a skin area as small as 64 square inches. Death from acute exposure to phenol may occur within 30 minutes. The ACGIH recommends an 8-hour time-weighted average TLV of 5 p/m phenol per cubic meter of air.

631-2.4.2.13 Polyamide. Polyamide has mild skin irritant and skin sensitizing properties.

631-2.4.2.14 Super High-Flash Naphtha, Boiling Range 157-179°C (315-353°F). This chemical contains up to 98 percent aromatic hydrocarbons. Some of the aromatics in super high-flash naphtha (for example, mesitylene)

are highly toxic by inhalation. However, the fairly low vapor pressure of these components reduces the inhalation hazard when the solvent is used in ventilated areas. Inhalation of the concentrated vapors can cause headache, nausea, and coma.

631-2.4.2.15 Chromates. Formulations containing chromates should already be appropriately labeled with the identity of the components and hazards warnings. Chromates, especially zinc and strontium chromates, are considered carcinogens.

631-2.4.2.15.1 Zinc chromate should be regarded as a material which is strongly suspected of having the potential to cause cancer in workers overexposed to this substance. The worker needs to be alerted to the following statements regarding zinc chromate containing compounds:

- a. Overexposure to zinc chromate may create an increased cancer risk for personnel.
- b. May cause irritation, rash or external ulcers.
- c. Consult supervisor, product label and MSDS for additional health hazard information and appropriate control measures.
- d. Seek prompt medical assistance in the event of skin irritation/dermatitis, eye contact or any other adverse health effect experienced while using this material.

631-2.4.2.15.2 Chromate exposure may occur during the application and removal of surface coatings containing this compound.

631-2.4.2.16 Lead. Lead may be present in paints as a pigment or as a drying agent. In many cases, lead may be present only in small quantities (<0.5%).

631-2.4.2.16.1 Lead is a systemic poison that may result in damage to blood forming, nervous and reproductive systems if subjected to overexposure. Following the requirements of OPNAVINST 5100.19 Series is paramount in controlling hazards of lead exposure and protecting the worker's health.

631-2.4.2.16.2 Airborne exposure in excess of 30 micrograms per cubic meter of air triggers numerous health, protective clothing, and equipment and medical surveillance requirements of OPNAVINST 5100.19 Series. An industrial hygienist from a tender, NEPMU or local Medical Treatment Facility shall be consulted if there is any reason to suspect an exposure to lead. This may occur during spray painting operations and/or paint removal operations.

631-2.4.2.17 Cadmium. Cadmium compounds such as cadmium selenide (CDSE) and cadmium sulfide (CDS) have often been used as red, yellow and orange paint pigments, especially in safety signs. These cadmium compounds provide stability to the coating systems in extremes of heat and sunlight and in the vicinity of industrial chemicals. The presence of cadmium in paints may not be readily evident if the constituent was not explicitly specified in the formula or material safety data sheet.

631-2.4.2.17.1 Lung cancer and renal dysfunction (kidney disease) have resulted among workers and animals exposed to cadmium. The permissible exposure limit (PEL) of five micrograms of cadmium per cubic meter of air applies to all cadmium compounds, dust and fumes.

631-2.4.2.17.2 Cadmium exposure may occur during the application or removal of surface coatings containing cadmium. In addition to its inclusion in paints, cadmium is frequently used as an anticorrosive electroplated onto steel. Therefore, precautions similar to those for lead and chromium removal should be taken when preparing surfaces of equipment which contain cadmium plated steel parts (e.g., fasteners, springs, etc.).

631-2.5 FLAMMABLE COATING APPLICATION IN ENCLOSED SPACES

631-2.5.1 GENERAL. Provisions for adequate ventilation and accidental ignition precautions are major factors in controlling the hazards inherent in the application of flammable coatings in enclosed spaces. The many variables in each situation prohibit complete reliance on standardized tables or guidelines. The hazards requiring control when flammable coatings are applied in enclosed spaces, and the precautions to be observed, are described in the following paragraphs.

631-2.5.2 VENTILATION. Experience is the best guide in determining the approximate amount of ventilation that should be supplied to a specific space under a particular set of circumstances. In addition to the general considerations and precautions described herein, see **NSTM Chapter 074, Volume 3, Gas Free Engineering**, for specific requirements concerning gas free engineering.

631-2.5.2.1 Enclosed Spaces. The placement of ducts, blowers, and other ventilation aids is a unique problem which will vary according to the shape, size, and number of openings in a tank or enclosed space. Frequent testing of a space is necessary because the amount of ventilation required for a space will vary, even though obvious controlling factors (the number of blowers and painters) remain constant.

631-2.5.2.1.1 Field tests have shown that exhaust fans hooked in parallel or series often fall short of their rated or theoretical delivery capacities. The size, type, and amount of duct work are generally the controlling factors for the ventilation system rated capacity.

631-2.5.2.1.2 Field tests have shown that during spray painting of submarine ballast tanks, high vapor concentrations in the tank occur most frequently when the painter is in the upper half of the tank. Venting a tank by blowing air through a bottom opening is not a good practice because of the tendency for vapors from solvents used in flammable coatings to collect in pockets. These pockets can readily form in the space being painted, in adjacent areas open to solvent vapors, and in drydock areas. Small blowers of various types have been used to circulate the air in areas where regular blowers are ineffective. Flooding of dry dock sumps has been used to reduce the amount of mechanical ventilation needed.

631-2.5.2.1.3 Adequate ventilation does not preclude accumulation of explosive concentrations within limited areas adjacent to a spray nozzle. The actual size and shape of these areas will depend upon several factors: air movement rate, air movement direction, and space/tank configuration. Based on test results, this explosive concentration area probably does not extend more than 5 feet from the nozzle. In these tests, samples were taken above the nozzle only; however, the 5-foot distance applies in all directions from the nozzle.

631-2.5.2.2 Guidelines. The following ventilation guidelines are for guidance only. The exact capacity and distribution of equipment and ducts shall be determined by the activity. Ventilation effectiveness shall be determined by the readings obtained by the Gas Free Engineer. These readings shall be used to determine the type of ventilation (supply or exhaust) required and routing of duct work.

1. Use outside (fresh) air for supply, and exhaust directly to outside air.
2. Carefully consider the number, placement and capacities of blowers; the number and size of flexible ducts; and size and shape of space to obtain maximum uniform air distribution. Supply more air than indicated, rather than less.
3. The point of exhaust shall be as far as practical from the point of supply.
4. To obtain uniform air distribution and minimize vapors concentrations, use as many feeder ducts as needed, placed appropriately throughout each space or tank.
5. Place additional ducts in areas where vapors may collect. Solvent vapors are heavier than air and tend to collect at lower levels.
6. Use venturi-type exhaust blowers, which operate on compressed air, wherever possible ([Table 631-2-2](#)). Centrifugal exhaust blowers with much larger capacities are available. Noise levels generated by these exhaust blowers, as a result of high airflow, may exceed NAVOSH-permissible levels. Personnel exposed to noise levels of 84 decibels (dB) or above shall wear approved earplugs or ear muffs. At noise levels greater than 104 dB, double protection (both earplugs and ear muffs) shall be worn.
7. The rated or nameplate capacity of all blowers should be verified with measuring instruments at regular intervals.
8. The selection of supply or exhaust ventilation shall be based upon the internal configuration of the space, location of openings, staging or internal structure distribution, blower availability, whether ship is in drydock, and other similar considerations.

631-2.5.2.3 Safety Precautions. Ventilation requirements shall be established based on past experience and results of periodic tests for ventilation adequacy and shall be revised as necessary. In addition, the following precautions shall be observed.

- a. The point of exhaust in a tank or space shall be as far away from the point of air entry as feasible.
- b. Air which is being exhausted from a tank shall be exhausted above the tank or space and, if feasible, above the hull of the ship.
- c. As few painters as practical shall be permitted to work in the tank or space at any one time to keep vapor concentrations as low as possible.
- d. Personnel shall be informed that solvent vapors collect more readily in humid, foggy, and rainy weather, and of the need for extra precaution.
- e. Discharge of contaminated air must be released overboard and in a manner which precludes possible re-entry into the vessel.

Table 631-2-2 VENTURI-TYPE EXHAUST BLOWERS

Catalogue No.	Model (in.)	Weight (lb)	Gauge Pressure (lb/in²)	Compressed Air Std (ft³ /min)	Induced Air Std (ft³ /min)	Discharged Air Std (ft³ /min)
32119	3	6.5	20 to 100	60 to 240	740 to 1400	800 to 1640
32120	6	31	20 to 100	120 to 670	2550 to 6950	2670 to 7620
33552	10	47	20 to 100	330 to 1100	3800 to 9700	4130 to 10800

631-2.5.3 TESTING. Inflexible rules as to test location and frequency are not advisable; however, for guidance purposes, certain minimum shall be established.

631-2.5.3.1 Guidelines. Well trained qualified gas free test personnel are essential for maximum safety. Test personnel shall be thoroughly trained in the hazards associated with the use of coatings and materials being handled and applied, including behavior of the solvents (for example, tendency to collect in pockets and behavior under varying weather conditions). They shall also be given sufficient background information to be able to anticipate problem areas that might develop under particular sets of circumstances. The personnel shall then determine the frequency of testing and locations where tests are needed to achieve maximum safety. For pertinent information concerning combustible gas indicators (explosimeters), see **NSTM Chapter 074, Volume 3, Gas Free Engineering** .

631-2.5.3.2 Safety Precautions. Testing shall begin concurrently with the painting operation and shall continue until all areas involved are tested and certified, "safe for entry." The maximum allowable solvent concentration is 10 percent of the LEL. Periodic tests shall be made throughout the space being painted, at the exhaust areas, at the air intake areas, and in all other areas, drydocks, adjacent tanks, mixing areas, and storage areas where explosive vapors may collect.

631-2.5.3.2.1 Tests made at the point of exhaust shall be made solely to determine whether an explosive vapor is concentrated at the exhaust. They shall not be used to determine whether there are explosive concentrations within the space or tank. Tests shall be made at the air intake to be certain that explosive mixtures are not being drawn into spaces. The latter test is particularly important when other spaces or tanks in the area are being painted.

631-2.5.3.2.2 All readings taken by the gas free test personnel shall be logged and a minimum test frequency shall be established. A gas tester shall predetermine a course of action to follow if explosimeter readings are above the maximum allowable level. Repeat tests for residual vapor pockets shall be made after an area has been pronounced gas free.

631-2.5.4 ACCIDENTAL IGNITION. The principal sources of accidental ignition are open flames, sparks from welding operations, sparks from electrical equipment, sparks from static electricity, and contact sparks (those generated by the striking of steel or concrete, for example). A survey of minor flash fires indicated that the majority resulted from welding, burning, or grinding operations in the vicinity of areas that had not been pronounced gas free. However, these functions should be safety-engineered rather than unduly restricted.

631-2.5.5 IGNITION PREVENTION PRECAUTIONS. In addition to observing good housekeeping practices, the precautions in the following paragraphs shall be observed to prevent accidental ignition of solvent vapors.

631-2.5.5.1 Danger Area. A danger area for each painting operation shall be defined by the local activity and clearly identified and marked by signs. A danger area is that area in which explosive mixtures may collect.

631-2.5.5.2 Explosion-Proof Light Fixtures. Explosion-proof light fixtures shall be used in danger area. Only explosion-proof light fixtures approved for use in Class I, Group D atmospheres shall be used. Portable explosion-proof fixtures approved for shipboard use, in accordance with MIL-F-16377 are considered adequate. The light fixtures listed in [Table 631-2-3](#) are the only portable fixtures approved as explosion-proof under the foregoing specification.

631-2.5.5.2.1 All other types of explosion-proof fixtures shall have underwriter approval for Class I, Group D atmospheres, in accordance with the National Electrical Code. Fixtures shall not be repaired nor lamps replaced within the danger area. Fixtures shall be completely and properly assembled prior the start of work.

631-2.5.5.2.2 Portable light fixtures should be hung from sparkproof hooks. Cords shall never be wrapped around nor draped over supports.

631-2.5.5.3 Blowers. All blowers shall be equipped with explosion-proof motors and associated control equipment (Class I, Group D), and shall be properly maintained and grounded. Proper maintenance includes checking the flame gaps between the joint surfaces to preclude exceeding safe limits. These flame gaps shall not be gasketed nor painted since this would destroy their basic function. Holes shall not be drilled through explosion-proof enclosures. Enclosure parts shall not be machined in such a manner as to decrease the flame gap. Bolts shall not be omitted nor permitted to become loose, and bolts of smaller diameter than the originals shall not be used. Spray guns and kettles shall be adequately bonded and grounded to the ship.

631-2.5.5.4 Electrical Grounds. Ships being painted in drydock shall be electrically grounded and painting operations shall be suspended during electrical storms.

631-2.5.5.4.1 Solvent storage tanks and transfer lines shall be grounded. Metal containers such as buckets, when used to transfer solvents, shall make metal-to-metal contact with the equipment when filling and emptying. Metal-to-metal contact shall also be made when pouring solvent from one bucket to another (as in mixing).

Table 631-2-3 EXPLOSION-PROOF FIXTURES

Manufacturer	Type or Model
Crouse Hinds Company	RCDE-6 or RCDE-6
Russel and Stoll	F4255A
Steward R. Browne Manufacturing Company	XP, 100 watts; XPN and XP-100-M

631-2.5.5.5 Electrical Equipment. Electrical equipment and circuits within the danger area shall be deenergized, with the exception of explosion-proof equipment and associated power cables. Connections for necessary electrical services shall be made outside the danger area. Only electrical leads with intact insulation shall be used within the danger area.

631-2.5.5.6 Spark Prevention. No welding, cutting, open flame, or smoking should be permitted in the danger area until tested and certified "safe for entry," and then only for the amount of time specified. These restrictions should apply aboard any ship being painted. Ships in commission should exhibit the danger signal (BRAVO flag or red light).

631-2.5.5.6.1 To prevent sparks, personnel engaged in handling or applying these coats shall wear rubber-soled shoes. They shall not wear plastic protective clothing (see paragraph 631-2.2.4.9), and shall remove from their persons all sources of ignition (for example, matches, cigarette lighter, and steel buckles).

631-2.5.5.6.2 All material and equipment (for example, blowers, duct work, spray guns, power tools, paint brushes, and buckets) shall be of such material and construction that the possibility of a spark being generated is precluded. If metal staging is used, it shall be installed with wooden or nonferrous plugs or fittings to elimi-

nate the possibility of sparks. A periodic check system shall be established to ensure that explosion-proof light fixtures, spray gun assemblies, and other equipment used during painting operations have no exposed ferrous metal parts which could strike a spark on contact.

631-2.6 POLYURETHANE COATINGS

631-2.6.1 GENERAL. Once cured, polyurethane coating generally presents no special hazard to health, but does present special problems during mixing, application, and curing because of the possibility of free isocyanate vapors being liberated. These isocyanate vapors can cause irritation of skin, eyes, and respiratory tract. Exposed persons can be sensitized and made allergic to isocyanates. Subsequent exposure to very small amounts of isocyanates can cause severe allergic reactions in sensitized individuals and may produce asthma-type symptoms. If sensitization occurs, it tends to be permanent and generally precludes further exposure of that person to isocyanates. The potential for overexposure, is a function of the materials in use, as well as the magnitude/duration/location of the operation. It is advisable to consult the applicable Material Safety Data Sheet (MSDS), Product Information Sheets, Container Labels, and Safety and Occupational Health professionals for additional/specific guidance and precautions needed to perform the operation safely. The DOD Hazardous Material Information Service (HMIS) also serves as an additional source of hazardous materials information which may be of benefit.

631-2.6.2 POLYURETHANE COATING REQUIREMENTS AND PRECAUTIONS. Special requirements and precautions for polyurethane coatings, which include aircraft coatings are given in the following paragraphs.

631-2.6.2.1 Commander Responsibilities. Commanders of activities where polyurethane paints or other substances containing isocyanates are used shall ensure that the following steps are completed.

- a. Step 1. Ensure that an industrial hygiene survey of work areas is conducted at least once each year. Reviews shall be planned and performed prior to any large-scale operation.
- b. Step 2. Ensure that the polyurethane coatings and related substances issued are used only for authorized applications. Materials shall be used in accordance with the precautionary measures outlined in paragraph [631-2.6.2.3](#) and with measures recommended as the result of on-site industrial hygiene surveys.
- c. Step 3. Ensure that medical evaluation and surveillance of all personnel exposed to isocyanates are conducted in accordance with paragraph [631-2.6.4](#).

631-2.6.2.2 Personnel Medical Evaluations. Commands shall be responsible for requiring medical evaluations of all personnel (prior to their detachment) who have been ordered to attend courses involving application of polyurethane paints. The evaluation shall be in accordance with paragraph [631-2.6.4](#) and shall be documented in the health record. Persons found to be medically qualified shall present a copy of the medical evaluation upon reporting for the course. Persons found not medically qualified shall be retained by the command, and cancellation or change of orders shall be requested in accordance with current directives.

631-2.6.2.3 Restrictions on Issue and Use. Polyurethane paints and other substances containing unreacted isocyanates shall be restricted to use in the following situations:

- a. Production type mixing and spray painting operations employing standard vibrator, air-supply, or airless type spray guns.
- b. Touch-up of small, localized areas, see paragraph [631-2.6.2.4.2](#).

- c. Application of polyurethane coatings is considered to be a depot level maintenance item and, other than touch-up of less than 1% of the original area, is not ships' force activity.
- d. Such other uses as may be specifically approved by BUMED and by appropriate safety organizations.

631-2.6.2.4 Environmental Control Measures. Polyurethane paints and related substances shall be prepared and used in accordance with the environmental controls specified in the following paragraphs.

631-2.6.2.4.1 Production-type operations shall be performed only in specifically designated areas with local exhaust ventilation and such other environmental control measures as may be recommended on the basis of an on-site industrial hygiene survey.

631-2.6.2.4.2 Touch-up operations shall be performed only in areas with good general ventilation, such as the hangar deck of a carrier or in a shore hangar with the doors open. Unprotected personnel in adjacent areas shall not be exposed to mist, spray, or vapor. Application shall be restricted to brush, roller, or self-pressurized aerosol spray kits such as the Jet-Pak (NSN 4940-00-803-6444 SX). No individual shall apply more than 1 quart of polyurethane paint by self-pressurized spray kit in any 24-hour period.

631-2.6.2.4.3 Other specifically authorized uses shall include observance of specified environmental controls.

631-2.6.3 PERSONAL PROTECTIVE EQUIPMENT. Personnel preparing or applying polyurethane paints or related materials shall be equipped with appropriate personal protective equipment as described in the following paragraphs.

631-2.6.3.1 Production-Type Operations. Protective equipment is recommended as a result of on-site industrial hygiene survey.

631-2.6.3.2 Touch-up Operations. Protective equipment for touch-up operations consist of the following items as a result of an on-site industrial hygiene survey:

- a. A well-fitted supplies air respirator or a well-fitted organic vapor respirator (NSN 4240-00-276-8935) with fresh cartridges (NSN 4240-00-272-9958) inserted daily (or as needed) provided that concentrations are within limitations of the air-purifying respirator. See OPNAVINST 5100.19B and OPNAVINST 5100.23B.
- b. Solvent-resistant gloves, conforming to specification ZZ-G-381C, Type III.
- c. Safety goggles conforming to specification GGG-G-521E.
- d. Full clothing with collar buttoned and sleeves taped at wrists.

631-2.6.3.3 Other Equipment and Measures. Other equipment and hazard control measures should be as specified by the cognizant BUMED industrial hygienist, based on a specific site survey of actual operations to be performed.

631-2.6.3.4 Substitute Protective Equipment. Substitution of other items for those listed in paragraph [631-2.6.3.2](#) is explicitly prohibited unless such substitution has been specifically approved in writing by the Cognizant BUMED industrial hygienist or by the appropriate safety organization. The MARK V protective mask shall not be used in polyurethane painting operations nor in work involving related materials.

631-2.6.4 MEDICAL EVALUATION AND SURVEILLANCE. Personnel selected to perform tasks involving the preparation or application of polyurethane paints or other substances containing unreacted isocyanates shall be referred to the medical department for medical evaluation prior to performing such tasks. Placement in the medical surveillance program shall be in accordance with the requirements of the OPNAVINST 5100.19 Series. Medical surveillance examinations shall be conducted in accordance with the requirements of the Medical Surveillance Procedures Manual and Medical Matrix (Edition 4) NEHC TM 91-5.

631-2.6.4.1 In Event of Certain Symptoms. Persons occupationally exposed to polyurethane paints or other substances containing unreacted isocyanates who develop symptoms of cardiorespiratory disease, skin irritation, or eye irritation shall be referred to a physician for evaluation.

631-2.6.5 HEALTH RECORD ENTRIES. When a person is found to be sensitized to isocyanates, the following entry shall be entered in that person's health record on NAVMED 6150/20, Problem Summary List: Sensitized to isocyanates.

631-2.7 ORGANOTIN (TBT) ANTI-FOULING MATERIALS.

The HMIS and/or the MSDS of the product in use should be consulted for guidance relative to the potential health hazards and measures which must be taken to allow the material to be used safely.

631-2.7.1 GENERAL. Depending upon EPA, state and local water quality limits for tin, organotin paints may be used as anti-fouling coatings for aluminum underwater hulls to extend operating cycles and improve fuel efficiency. Organotin anti-fouling rubbers are used in some sonar domes and in other applications where rubber sheets that are resistant to marine fouling are desired. Although handling operations are different for organotin anti-fouling paints and rubbers, the same basic safety precautions apply for both.

631-2.7.2 ORGANOTIN ANTI-FOULING PAINTS. Anti-fouling paints that contain organotin compounds are extremely irritating to the skin, eyes, and respiratory tract by either direct contact with the paint or coated surfaces or by exposure to vapors or mists. Eye and respiratory irritations usually occur immediately upon exposure. Skin irritation normally occurs within 24 hours of exposure. Harmful exposures can result from welding and burning operations, contact with wet paint, paint mist, or dried paint overspray, and contact with contaminated sandblasting residue. Any operations involving welding, burning, grinding, sanding, or otherwise heating the dried coating will release toxic and irritating dust or vapors. When using these materials, controls are required to prevent harm to personnel and the environment. Copolymer (chemically bound) organotin paints are less hazardous than anti-fouling paints with high concentrations of organotin compounds as free additives. These copolymer paints with either tin or a blend of tin and copper are less hazardous than Formula 170 (old 1020) which is no longer approved for general use. Only 100 percent tin copolymer paints are approved for aluminum hulls.

631-2.7.2.1 Organotin Operations Guidelines. Shipyards engaged in organotin operations shall follow the guidelines contained in the NAVSEA Uniform Industrial Process Instruction (UIPI) 6313.N005.

631-2.7.2.2 Professional Technical Services. Users of commercial organotin and other commercial coatings should avail themselves of the technical support services offered by the paint manufacturers supplying the paints.

631-2.7.3 GENERAL INDUSTRIAL HYGIENE REQUIREMENTS FOR ORGANOTIN MATERIALS. Organotin compounds are used in anti-fouling materials. All organotin anti-fouling materials shall be handled as specified in the following paragraphs. These requirements are designed to protect the health and provide for the

safety of personnel for up to an 8-hour work shift in a 40-hour workweek. Although the Navy Environmental Health Center considers the established workplace environmental limit to be a safe level based on current information, every effort shall be made to maintain the exposure as low as is technically feasible. Consult MSDS for health hazards of the material in use.

631-2.7.4 ORGANOTIN SAFETY PRECAUTIONS. Observe the following safety precautions:

1. Avoid inhaling vapor, mist, dust, or fumes.
2. Avoid direct bare skin contact with paint or painted surfaces or rubber structures that contain TBT (such as in some radar domes).
3. Avoid eye or skin contact with mist or spray.
4. Do not eat, drink, or swallow organotin.
5. Avoid contact between hands and mouth if hands have been exposed to the material.
6. Food, drink, and smoking materials are not permitted in work areas. Eating, drinking, chewing, and smoking are prohibited in work areas.
7. Items with organotin coating shall not be introduced into the ship interior unless enclosed in unbreakable (not glass) vapor tight containers.

631-2.7.5 TERMINOLOGY. Terminology applicable to organotin exposure is defined in the following paragraphs.

631-2.7.5.1 Occupational Exposure. Occupational exposure occurs when exposure exceeds the action level or if skin or eye contact occurs.

631-2.7.5.2 Overexposure. Overexposure occurs if a worker is known to be exposed at a concentration in excess of the exposure limit, or is exposed at any concentration sufficient to produce irritation of eyes, skin, or respiratory tract. When overexposure occurs, contact the medical department. If industrial hygiene services are required, contact the local Industrial Hygienist or the nearest NAVENPVNTMEDU or NRMCMC.

631-2.7.5.3 Emergency. Emergency is defined as any disruption in work process or practice (such as, but not limited to equipment failure, container rupture, or control equipment failure) which is likely to result in unexpected exposure to quantities capable of causing harm.

631-2.7.6 WORK AREA AIR QUALITY. Air quality in work areas shall be regulated as described in the following paragraphs. A workplace assessment, as conducted by an industrial hygienist or by a qualified technician, is necessary to assist in making recommendations regarding the protection of personnel.

631-2.7.6.1 Permissible Exposure Limit (PEL). Exposure shall be controlled so that no worker is exposed to a concentration of organotin exceeding a PEL of 0.1 mg/m³ of air averaged over an 8-hour work shift.

631-2.7.6.2 Action Level. Action level is set at half the Permissible Exposure Limit, Time-Weighted Average (PEL-TWA).

631-2.7.6.3 Sampling and Analysis. Work area air samples shall be collected and analyzed under the guidance of a qualified Industrial Hygienist.

631-2.7.7 LABELING AND POSTING OF ORGANOTIN WARNINGS. Supervisors shall ensure that workers are aware of organotin hazards and of hazardous areas. In any workplace or area where there is a potential for emergency situations to arise, supplement required signs by additional signs giving emergency and first aid instructions, locations of first aid supplies, emergency equipment, and locations of emergency eyewash fountains. Warning labels and hazard notices required in organotin work areas are described in the following paragraphs.

631-2.7.7.1 Respirator. If respirators are required, add the following statement in large letters to the signs required in the following paragraphs: SPECIAL RESPIRATORY PROTECTION REQUIRED IN THIS AREA.

631-2.7.7.2 Organotin Labels. Containers shall carry a label approved by EPA/FIFRA.

631-2.7.7.3 Organotin Work Areas. Post area where organotins are used in readily visible locations. Arrange this information as in [Figure 631-2-1](#).

631-2.7.8 INFORMING WORKERS OF ORGANOTIN HAZARDS. Requirements for informing workers of hazards are given in the following paragraphs.

631-2.7.8.1 Provide information on the hazards, physical symptoms, appropriate emergency procedures, and proper conditions and precautions for the safe handling or use of organotin to workers in areas where exposure may occur. Training shall include the use of Personal Protective Equipment (PPE). Include workers engaged in maintenance and repair in these training programs.

631-2.7.8.2 Institute an educational program, conducted by persons qualified by experience or training, to ensure that personnel have a knowledge of job hazards, the proper maintenance, clean up methods, and proper respirator usage. The instructional program shall include a description of the general nature of the medical surveillance procedures and of the advantages to the worker of undergoing these examinations. As a minimum, instruction shall include information included in the Material Safety Data Sheet (MSDS) for each substance. Keep the MSDS on file and readily accessible.

631-2.7.9 PERSONNEL PROTECTIVE EQUIPMENT AND CLOTHING. Use engineering controls and safe work practices to keep airborne concentrations of organotin below the PEL specified in paragraph [631-2.7.6.1](#), as is technically feasible. Use rollers or brushes to the fullest extent possible to minimize overspray. Use protective clothing and equipment impervious to organotin to prevent skin and eye contact.

631-2.7.9.1 Safety Goggles. When a full facepiece respirator is not used, provide chemical safety goggles or face shields (8-inch minimum) and require personnel to wear the protective equipment during any operation in which organotin may enter the eyes.

631-2.7.9.2 Protective Clothing. Provide appropriate impervious clothing, including gloves, aprons, suits, hoods, and boots. Require workers to wear protective clothing where needed to prevent skin contact.

631-2.7.9.3 Respiratory Protection. Use engineering controls to maintain concentrations as far below the PEL as is technically feasible. Use respiratory protective equipment in the following circumstances.

- a. During the time necessary to install or test engineering controls.
- b. For operations (such as maintenance and repair) causing brief exposure at concentrations in excess of the PEL.
- c. During emergencies when concentrations of airborne organotin might exceed the PEL.
- d. When engineering controls are not feasible to maintain atmosphere concentrations below the PEL.

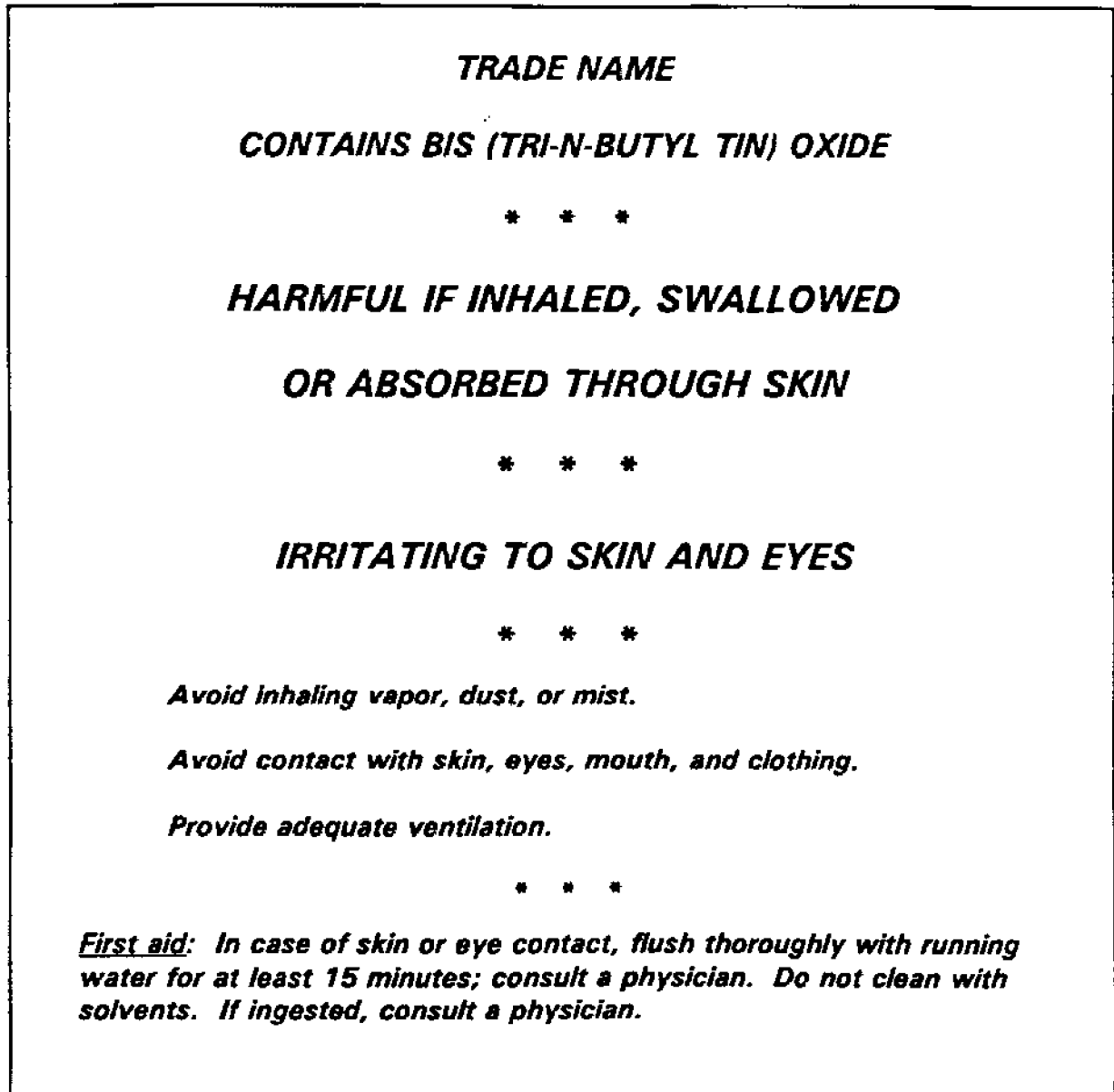


Figure 631-2-1 Example of Organotin Work Area Warning Sign

631-2.7.9.4 Respirator Requirements. When respirators are required, they shall be selected in accordance with [Table 631-2-4](#). Respirators are required and shall be worn within the immediate work area and an area extending out to 25 feet from the spray painting operation. Respirators specified for use in higher concentrations of TBT may be used at lower concentrations. Use, training and medical requirements of OPNAVINST 5100.19 Series shall be followed.

631-2.7.9.4.1 When a self-contained breathing apparatus is permitted in accordance with [Table 631-2-4](#), it shall be used pursuant to the following requirements.

Table 631-2-4 SUGGESTED RESPIRATORY PROTECTION FOR ORGANOTIN ANTI-FOULING PAINTS

Condition	Minimum Respiratory Protection ¹
FRINGE AREA 50 to 100 feet away from work site	1. Full facepiece respirator with combination high efficiency filter and inorganic vapor canister (pesticide respirator).
WORK SITE For Sprayers, Abrasive Blasters, Paint Mixers, and other personnel in the work area (less than 50 ft away)	1. Self-contained breathing apparatus, with a full facepiece, operated in pressure-demand mode, or 2. Combination supplied-air respirator, with full facepiece and an auxiliary self-contained air supply, operated in pressure-demand mode.
FIREFIGHTING	1. Self-contained breathing apparatus, with full facepiece, operated in pressure-demand mode, worn with impervious clothing.
NOTE: ¹ The local Industrial Hygienist may establish different respirator requirements based on the conditions. These recommendations are based on use of airless spray equipment and coatings less than 5 percent of organotin expressed as tin. Only NIOSH/MSHA-approved respirators shall be used.	

- a. Initial training and refresher courses on the use, maintenance, and function of self-contained breathing apparatus shall be mandatory.
- b. Whenever a self-contained breathing apparatus is used, the respirator shall be operated in the pressure-demand mode.

631-2.7.9.5 Breathing Air Quality. Sources of air for supplied-air respirators, and for refilling of self-contained breathing apparatus, shall conform to the requirements of OPNAVINST 5100.19 Series.

631-2.7.10 WORK PRACTICES. Work practices governing various aspects of organotin handling, use, cleanup, and storage are described in the following paragraphs.

631-2.7.10.1 Emergency Procedures. In each work area where there is a potential for emergencies involving organotin, take all necessary steps to ensure that workers are instructed, and follow the specified procedures and any other procedures appropriate for the specified operation or process. The local industrial hygienist should be cited as the local authority for various aspects of emergency procedures such as personal protective equipment.

631-2.7.10.1.1 Instructions shall include prearranged plans for obtaining emergency medical care and for transportation of injured employees.

631-2.7.10.1.2 Approved eye, skin, and respiratory protection shall be used by personnel essential to emergency operations. Evacuate personnel not essential to emergency operations from areas where inhalation, ingestion, or direct skin or eye contact may occur. Mark the perimeter of these areas, post and secure.

631-2.7.10.1.3 Provide eye wash fountains conforming to ANSI-A358.1. A portable eye wash facility shall be immediately available and shall be capable of supplying at least 0.4 gallons of potable water per minute for 15

minutes. Provide capability for flushing both eyes simultaneously. Promptly wash eyes affected in any manner by the organotin paint in any eyewash fountain for at least 15 minutes, and then refer the individual to the Medical Department as soon as possible.

631-2.7.10.2 Control of Airborne Organotin. Use engineering controls whenever feasible to keep organotin concentrations within the required environmental limits.

631-2.7.10.3 Organotin Storage. Keep containers tightly closed at all times when not in use. Store containers in a safe manner to minimize accidental rupture and to prevent contact with strong oxidizing agents. Provide adequate ventilation to prevent the accumulation of organotin vapors.

631-2.7.10.4 Maintenance Personnel Safeguards. When undertaking maintenance work and there is no reliable assurance that the concentration of organotin in air will be kept at or below the PEL, respiratory protective requirements shall be met and personal protective equipment shall be used during such maintenance work. The respiratory protection must be selected based on the type and/or magnitude of exposure.

631-2.7.10.5 Skin Protection. Personnel who have had skin contact with organotin from wet or uncured surfaces shall immediately wash, and shower if necessary, for at least 15 minutes to remove all traces from the skin. Skin shall be cleaned only with soap and water. Remove contaminated clothing immediately to minimize contact with the skin. Handle contaminated clothing as hazardous waste consistent with local regulations or policy.

631-2.7.11 SANITATION. Restrictions and requirements concerning sanitation in organotin areas are described in the following paragraphs.

631-2.7.11.1 General. Prohibit eating, preparing and dispensing food (including vending machines) in organotin work or storage areas. Do not permit smoking and smoking materials in areas where organotin is used, transferred, or stored.

631-2.7.11.2 Personal Hygiene. Instruct personnel handling organotin or organotin-contaminated equipment to wash their hands thoroughly with soap or mild detergent and water before eating, drinking, smoking, or using toilets. All personnel shall wash with soap and water and shower without delay after removing protective clothing and equipment contaminated with organotin material. Do not use solvents or oil based cleaners to remove organotin from the skin.

631-2.7.12 MEDICAL MONITORING AND SURVEILLANCE OF PERSONNEL EXPOSED TO ORGANO-TIN. Personnel with occupational exposure to organotin shall be referred to the medical department for placement in the medical surveillance program in accordance with the requirements listed in the OPNAVINST 5100.19 Series. Medical surveillance examinations shall be conducted in accordance with the requirements of the Medical Surveillance Procedures Manual and Medical Matrix (Edition 4) NECH-TM91-5.

631-2.7.12.1 General. Personnel with signs or symptoms which may be caused by or aggravated by exposure to organotin in the workplace shall be referred to the medical department for evaluation. The Medical Department shall make an evaluation of the individual's capability to use respirators.

631-2.7.12.2 Medical Services. Provide appropriate medical services to personnel with adverse health effects reasonably assumed or shown to be caused by exposure to organotin in the workplace.

631-2.7.12.3 Emergency Examination. If an emergency involving organotin arises, a qualified medical professional shall examine all personnel in the affected area. Particular attention will be given to the lungs and eyes to determine the need for any treatment. If contact has occurred, remove any contaminated clothing and shoes immediately, and flush the eyes or skin immediately with water for at least 15 minutes.

631-2.7.13 INSTRUCTIONS AND SAFETY PRECAUTIONS FOR OPERATIONS INVOLVING ORGANO-TIN COATINGS. Only protected personnel shall remain within the exposure zone of organotin painting or removal operations. The exposure zone may extend as far as 100 feet, depending upon paint formulation, work methods, and other conditions evaluated by an Industrial Hygienist or at his/her technical direction.

NOTE

The local Industrial Hygienist shall determine preparations and controls necessary to protect personnel. Guidance given in this manual may be modified by the local Industrial Hygienist consistent with specific organotin formulations, controls, experience, and conditions.

631-2.7.13.1 Preparation for Spray Painting or Blast Cleaning. Cover ship intake ventilators within 50 feet with FILTER FAB (or equal) type of cover and close hatches within 50 feet to prevent entry of paint, blasting particles, or vapors into the ship. This condition shall continue until the paint has set and solvent odors cannot be detected. Also evaluate other craft in the same drydock in the downwind direction for potential hazard. It may be desirable to remove non-essential personnel. Take precautions to prevent circulation of paint mists and vapors throughout the interior of the ship.

631-2.7.13.1.1 Remove all unnecessary equipment from the immediate work area.

631-2.7.13.1.2 Thoroughly sweep (in a wet state) or vacuum all drydock and equipment surfaces after painting or blasting. Immediately clean up accidental spills. If any keel block, staging, plank, suspended platform, drydock, or equipment surface is painted with organotin paint, all paint shall be removed before the item is reused. Obtain assistance from an Industrial Hygienist in specifying necessary protective measures during cleaning procedures.

631-2.7.13.2 Protective Clothing. Personnel remaining in the drydock shall wear protective clothing appropriate to the location and task to be done. Issue clean protective clothing personnel before the beginning of each shift.

631-2.7.13.2.1 All personnel working within a 25-foot radius of paint application or removal shall wear impervious disposable coveralls, disposable shoe covers, and plastic or rubber gloves. See MSDS for type of gloves. Tape the protective clothing at the wrists and ankles. Respiratory protection shall be in accordance with [Table 631-2-4](#).

631-2.7.13.2.2 All personnel working within a 10-foot radius of paint mixing operations shall wear impervious coveralls, hoods, and face shields. Tape the protective clothing at the wrists and ankles. Respiratory protection shall be in accordance with [Table 631-2-4](#).

631-2.7.13.2.3 Immediately wash with soap and warm water any part of the body exposed to wet paint.

631-2.7.13.2.4 Personnel who must enter the dry dock during application, but are beyond the work area distance specified, shall wear protective eyewear and respirators in accordance with [Table 631-2-4](#).

NOTE

On a case by case basis, an Industrial Hygienist may specify other personal protective equipment when deemed necessary.

631-2.7.13.2.5 Personnel working in the vicinity of the organotin-coated hull following coating application shall wear protective clothing and face shield or goggles sufficient to prevent skin and eye contact with the coating. Clothing required shall depend upon the expected degree of exposure. If odors from the coating are noticeable in the vicinity of the ship, wear NIOSH/MSHA-approved organic-vapor respirators until conditions are evaluated and procedures established by an Industrial Hygienist.

631-2.7.13.2.6 Keep contaminated clothing segregated from non-contaminated items. At the completion of the job, clothing shall be either thoroughly laundered to remove residual material before re-use, or disposed of. The controlled disposal of contaminated clothing as hazardous waste is preferred.

631-2.7.13.3 Paint Mixing. The paint mixing area shall not be located downwind of the paint application area.

631-2.7.13.4 Paint Application. Apply organotin anti-fouling paints by brush or roller to the fullest extent possible to minimize overspray. Localized touch-up may be done with brush or roller. The local Industrial Hygienist will specify any additional precautions that may be necessary to protect personnel when spray painting is planned.

631-2.7.13.4.1 Do not perform hot work of any kind within a minimum of 25 feet of the work area during paint application. The Gas Free Engineer may specify a greater distance consistent with formulations and conditions.

631-2.7.14 WELDING REPAIRS AROUND ORGANOTIN MATERIALS. Except as noted below, do not perform welding or burning on organotin-coated surfaces until the organotin coating has been removed to bare metal to a minimum of 12 inches on all sides of the area to be burned or welded. Cleaning by burning off the organotin coating is prohibited. Burners and welders shall wear NIOSH/MSHA approved supplied-air (preferably pressure-demand) respirators and heavy cotton coveralls taped at the wrists.

631-2.7.14.1 Welding on Opposite Side of Painted Physical Barrier. Where welding is performed on the inside of a surface coated on the outside with organotin paint and there is a physical barrier between the coated surface and the painter (i.e., welding on the inside surface of a hull coated on the outside) removal of organotin coatings is not necessary, but caution signs must be posted in the area surrounding the outside painted surface and everyone must be evacuated from locations at least 10 feet from the area where welding will occur.

NOTE

For repairs where burn-through (i.e., cutting) or thermal destruction of the hull coating is anticipated or experienced, remove the organotin coatings as required above (i.e., to bare metal within at least 6 inches on all sides of the area to be welded or burned).

631-2.7.15 INSTRUCTIONS AND SAFETY PRECAUTIONS FOR ORGANOTIN PAINT REMOVAL. The instruction and precautions described in the following paragraphs apply to the removal of organotin paints.

631-2.7.15.1 Personnel Protective Clothing and Safety Precautions. Abrasive-blast operators shall wear required protective equipment and clothing with openings taped including a full face Type CE air supplied respirator. In addition, wear rubber boots and impervious coveralls as the outer garments. Support personnel shall wear rubber boots and gloves, impervious coveralls, full eye protection, and NIOSH/MSHA-approved full face air supplied respirators or full face respirator equipped with pesticide cartridges.

631-2.7.15.1.1 Personnel cleaning the work area and removing used blasting grit shall wear full eye protection, NIOSH/MSHA-approved dust respirators, rubber boots, gloves, and disposable taped coveralls.

NOTE

Protective equipment which may be contaminated with organotin material shall be carefully cleaned. Procedures may range from simple water washdown of abrasive blasting protective equipment to plastic sleeving on airline hoses or washing with detergent. Personnel handling items potentially contaminated with organotin material shall wear rubber gloves and disposable coveralls. Use of compressed air for cleaning purposes (blowing down blasting grit) is prohibited.

631-2.7.15.1.2 Other personnel who must work in the drydock, or in the open during periods when organotin coating dust is airborne, shall wear coveralls with taped openings, gloves, shoe covers, full eye protection, and NIOSH/MSHA-approved chemical cartridge respirators (pesticide cartridges).

631-2.7.15.1.3 All personnel shall clean up immediately after removing protective clothing. Personnel shall wash equipment and shower unless other instructions have been provided for a specific job by the local Industrial Hygienist.

631-2.7.15.2 Organotin Paint Removal. If coating is to be removed, blasting as early in the drydocking period as feasible will minimize the potential for accidental exposure. Wherever possible, schedule this operation on back shifts or weekends. Before the start of abrasive blasting, remove all non-essential equipment and material from the drydock to minimize accidental exposure, and to prevent excessive cleanup.

631-2.7.15.2.1 Wet methods are required for removal. Use water spray rings on abrasive blast hoses or wet-blasting equipment to confine the dust produced. The fresh water wash pressure shall be in the range of 2,000 to 2,500 lb/in². This will minimize spreading of airborne organotin coating dust. Keep used blasting grit damp.

631-2.7.15.2.2 Until all drydock and staging surfaces contaminated with anti-fouling coating are thoroughly cleaned, personnel entering the drydock shall wear impervious coveralls, gloves, eye protection, and shoe covers.

631-2.7.15.2.3 Also observe precautions contained in paragraphs [631-2.7.13.1](#) and [631-2.7.13.2](#) concerning organotin compound application when these materials are removed.

631-2.7.16 INSTRUCTIONS AND SAFETY PRECAUTIONS FOR ORGANOTIN MATERIAL DISPOSAL. Personnel disposing of organotin materials shall comply with paragraph [631-2.7.15](#) and other instructions as

appropriate. Specific disposal instructions and safety precautions are described in the following paragraphs. Further information on disposal of pollutants can be found in **NSTM Chapter 593, Pollution Control**.

631-2.7.16.1 Organotin Waste Material Disposal. Disposal of organotin waste material shall be in accordance with all federal regulations such as the Resource Conservation and Resource Act (RCRA), Federal Insecticide and Rodenticide Act (FIFRA), Clean Water Act (CWA), EPA-approved anti-fouling paint registration labels, and state and local regulations and permits. Gather paint overspray and waste abrasive grit contaminated with organotin which accumulates in the drydock by sweeping or vacuuming. Federal EPA regulations currently allow typical drydock debris to be disposed of in sanitary landfills if state and local regulations allow it. Direct questions concerning disposal to the Engineering Field Division of the Naval Facilities Command to determine the state and local regulations and if changes in paints used affect its classification by federal, state, and local regulations. Since regulations on organotin disposal may change, records on landfill locations and quantities shall be kept. Disposal guidance shall be reviewed by NAVFACENGCOM.

631-2.7.16.2 Washdown Water and Organotin Contaminated Process Water. All discharges shall be in a manner consistent with the drydock National Pollutant Discharge Elimination System (NPDES) permits. If permits do not allow discharge, separate and collect all contaminated water from hydrostatic leakage in drydock. Wash down the drydock floor and collect washwater. Wash down all equipment used for collection and disposal and collect the washwater. Temporarily store all collected contaminated water in a holding tank or process immediately. Detoxify or treat all contaminated water collected at drydocks, including collection by an Industrial Wastewater Treatment System (IWTS), by a process approved by NAVSEA at each yard. The primary disposal method for the organotin washwater shall be into a sanitary sewer and the secondary method shall be into a carbon absorption filter, then a sanitary sewer. Effluent from carbon absorption columns may be discharged overboard or to the sewage treatment system dependent upon local restrictions. Handle all solid materials filtered from the IWTS and carbon absorption columns according to paragraph [631-2.7.15.1](#).

631-2.7.16.3 Alternate Disposal Methods. Any alternative disposal method shall be in conformance with applicable local, state, and federal regulations governing hazardous material disposal, and shall not constitute a hazard to the surrounding population or environment. Contact the Navy Environmental and Energy Support Activity or NAVSEA for further guidance.

631-2.7.17 DIVERS. Divers shall wear a well fitting wet suit with hood, gloves, boots, and a full face mask of the Jack Browne or Kirby Morgan, USN-Mk I, or MK 12 type. Wet suite thickness and insulation depend upon water temperature and diving time. Padding of wet suit wear areas (such as knees and elbows) is satisfactory. If a wet suit tears, or a diving mask floods, halt operations and flush affected areas thoroughly with potable water.

631-2.7.17.1 Coat skin which may come in contact with water with a water-insoluble cream before wet suits are donned. Protective cream is recommended.

631-2.7.17.2 Following underwater operations and before removal of wet suits and diving masks, thoroughly wash both equipment and diver. Personnel shall not make direct contact with the outside of the suit and mask until washing is complete.

631-2.8 PAINT REMOVAL METHODS AND TOOLS

631-2.8.1 GENERAL. To prevent injuries and property damage by improper use and handling of paint removal methods and tools, the following safety precautions and requirements shall be observed. Paint removal methods

and tools covered here include abrasive blasting, hydroblasting, electrically operated power tools, pneumatic power tools, solvent and chemical cleaning, and paint strippers. The removal of surface coatings may involve methods which can liberate toxic components of the coating, base material and the removal media. Workers performing such operations shall be protected from exposure to these toxic components per OPNAVINST 5100.19 Series. Consult previous sections of this chapter for health hazards of paint ingredients where applicable. A workplace assessment, as conducted by an industrial hygienist or by a qualified technician, is necessary to assist in making recommendations regarding the protection of personnel.

631-2.8.2 SAFETY PRECAUTIONS AND REQUIREMENTS FOR ABRASIVE BLASTING. The safety precautions and requirements that shall be taken to prevent introduction of abrasive-blasting materials into ship spaces and unprotected equipment, and to prevent injury to personnel and property damage, are described in the following paragraphs. These precautions apply to all abrasive blasting operations on or within the vicinity of naval ships undergoing any type of availability. The Commissioned Submarine and the Commissioned Surface Ship General Reactor Plant Overhaul and Repair Specifications (NAVSEA 0989-LP-037-2000 and 0989-LP-043-0000), respectively, shall be consulted for additional precautions before areas outboard of the reactor compartment or machinery spaces of nuclear powered ships are blasted with abrasives.

631-2.8.2.1 Preoperational Requirements. Abrasive blasting shall not be undertaken until positive steps have been taken to prevent contamination and spread of abrasives and dust to adjacent compartments, machinery, and equipment. Abrasives and dust can enter ships through open sea valves, hatches, ventilation systems, temporary openings, normal entryways frequently opened and closed, and entryways which must remain open to accommodate other work. If there is any possibility that abrasives can enter a ship or ship's compartment in spite of all possible precautions, critical machinery surfaces and parts, and electric and electronic equipment, shall be positively sealed or otherwise protected. Machinery components, such as reduction gears, open boilers, hotwells, and turbines in various stages of disassembly, are especially subject to damage from contamination. When abrasive blasting in-hull is required late in an availability and most adjacent areas are nearly complete, consideration shall be given to locating the source of blasting media in-hull near the site to be blasted, to minimize the length of hose containing high pressure air and grit. This will reduce the chance for a hose leak to cause damage to nearby equipment.

631-2.8.2.1.1 Prior to blasting operations, the responsible shop shall notify the ship force, and all other ships in the vicinity, of time and location of proposed abrasive blasting operations. All shops and the ship force shall take the following precautions to protect equipment and structures:

- a. Drop cloths and masking shall be used to prevent damage from the abrasive material.
- b. Temporary shields and other sealing or closing-off measures shall be used to prevent abrasives from entering machinery, pipes, seawater inlets, and pump wells through various openings.
- c. Where remote service connections provide water or ventilation, such as seawater from the auxiliary seawater system while the ship is in drydock, the inlet to the connection shall be positioned and measures taken to prevent the entry of blasting contaminants.
- d. Additional precautions shall be taken to the extent necessary to protect adjacent ships, buildings, and stores.

631-2.8.2.1.2 Personnel in or near the blasting area shall be warned of blasting operations. In all circumstances, close cooperation between ship and shipyard personnel is required.

631-2.8.2.1.3 The entire area to be blasted shall be visually inspected. Heavily rusted or corroded areas, damaged metal, and holes in the structure or piping shall be checked to determine if the technical examination is warranted, and for possible repair prior to blasting. Abrasive blasting hoses routed through compartments shall be identified by an appropriately marked sign posted in each compartment, warning against damaging the hoses.

631-2.8.2.2 Postoperational Requirements. After any blasting or contamination of ship interior, the equipment or components blasted or contaminated by abrasive dust shall be cleaned and tested in accordance with the applicable NSTM chapter prior to being put into service. The entire area shall be visually inspected for pits, scabs, and scars. Suspected wall thickness reductions shall be reported for further technical examination in accordance with **NSTM Chapter 100, Hull Structures** , and **NSTM Chapter 505, Piping Systems** .

631-2.8.2.3 Blasting Unit Operational and Maintenance Safety Precautions. Each abrasive-blasting hose and its control line shall be color-coded at both ends to avoid cross-connecting hoses or lines. Hoses shall be equipped with deadman controls, audio-visual signaling devices, and manually operated air supply choke valves. The deadman control shall be the type that requires continuous pressure by the blast operator, and secures the air pressure to the nozzle automatically in the event the nozzle becomes unattended. The high-pressure air supply choke valve shall be kept closed by the machine operator or pot tender at all times except during actual blasting.

631-2.8.2.3.1 Operational and maintenance procedures and safety precautions shall be developed and posted on each blasting unit and shall include the following requirements.

- a. Hoses and nozzles have been inspected and are in satisfactory operating condition.
- b. Color codes on both ends of each blasting hose match those on the control lines for that hose.
- c. Deadman controls are attached to the hoses prior to positioning aboard ship.
- d. Deadman control, horn, and light operate correctly prior to positioning aboard ship.
- e. Blast operators shall not circumvent the deadman control by tying down the deadman lever.
- f. Choke valve is closed until the blast operator signals readiness to commence blasting.
- g. Blast operators shall not overblast, pit, or scar the surface being blasted.
- h. Noise hazard areas are posted in accordance with OPNAVINST 5100.23.

631-2.8.2.4 Audio-Visual Operating Signals. The supervisor shall review audio-visual signals, operating procedures, and safety precautions weekly with all personnel directly involved in blasting operations. A signal horn (or buzzer) and a light mounted on the machine shall be used to establish positive communication from each blast operator to the machine operator or pot tender where there is no visual contact. Hand signals may be used when there is visual contact. Audio and visual signals shall be standardized and posted on each blasting unit, including signals for close choke valve, open choke valve, more abrasive, and emergency.

631-2.8.2.5 Protective Equipment. All blast operators shall wear abrasive blasting respirators (Type CE). Other mandatory clothing includes rubber or leather gauntlet gloves, safety shoes, and coveralls. The blast operator shall wear a safety belt or harness when working on staging or other elevated places.

631-2.8.2.5.1 Personnel other than blast operators, including machine operators, personnel doing chipping, grinding, scaling, and personnel engaged in work in the vicinity of abrasive blasting operations, shall wear full

eye protection and NIOSH/MSHA-approved respirators. Approved ear protectors shall be worn wherever the noise level is 85 dB or above. Both earplugs and earmuffs (double protection) shall be worn if the noise level exceeds 104 dB.

631-2.8.2.5.2 Staging shall be stable and correctly positioned for the safety, convenience, and comfort of the blast operator.

631-2.8.2.6 Operating Safety Precautions. The nozzle shall never be pointed in the direction or ricochet line of another person, even with the air and abrasive stream shut off. The blast operator shall always keep hands and other parts of the body away from the discharge nozzle, and shall never try to adjust the nozzle while the abrasive stream is flowing.

631-2.8.2.6.1 Hoses shall be secured, leaving only enough free length to be handled safely by the blast operator. All hoses, fittings, and so forth shall be inspected before blasting begins; worn parts shall be discarded.

631-2.8.2.6.2 When couplings are located where sudden parting would be hazardous, both coupled hoses shall be secured to a strong support or to each other.

631-2.8.2.6.3 Abrasive-blasting equipment shall be properly maintained because operation of damaged or poorly maintained equipment at high pressures is dangerous.

631-2.8.2.6.4 Whenever practical, hoppers and hopper tenders should be located on top of drydock walls rather than in the basin. This improves housekeeping and permits grit flow to be aided by gravity. Minimizing the number of people who must be in the dock basin reduces the risk of injury if a hose or connection should break, causing the hoses to whip.

631-2.8.3 SAFETY PRECAUTIONS FOR HYDROBLASTING. Although not considered to be as hazardous as abrasive blasting, hydroblasting uses water at high pressure which can cut through a body, causing serious injury or death. The precautions and protective personnel equipment described for abrasive blasting, and the special precautions given in the following paragraphs shall apply.

631-2.8.3.1 Visual Operating Signals. Prearranged visual signals shall include: Start, Stop, Increase Pressure, Decrease Pressure (for the pump), Shut Down Engine, and Bleed Pressure.

631-2.8.3.2 Pump Operator. One person shall be stationed at the pump at all times to monitor running condition, control reserve water level, make pressure adjustments, handle emergencies (such as a ruptured hose), perform emergency procedures (stop engine, bleed pressure), and clear hoses at ground or pump location. The pump operator shall maintain visual contact with the gun operator and his assistant, and respond immediately to their signals. Where this is not possible, audio signals shall be used, similar to those specified in paragraph [631-2.8.2.4](#). Pump operators exposed to noise levels of 85 dB or above shall wear approved earplugs or ear muffs. If the noise level exceeds 104 dB, then both earplugs and ear muffs (double protection) shall be worn.

631-2.8.3.3 Gun Operator. Two workers shall be assigned to each gun being operated and shall relieve each other as required. The assistant shall keep hoses clear of all obstructions, assist the operator as required by supporting the hose weight, be alert to potential hazards which may be encountered by the operator, and take corrective action as required. The assistant shall also observe work done by the pump operator, point out missed

areas, and provide visual signals to the pump operator as necessary. The gun operator and assistant shall wear wet-weather gear, face shield or goggles, work gloves, shoes with antiskid soles, and, when working from a scaffold or other elevated position, a safety harness.

631-2.8.3.4 Equipment and Operating Precautions. Hydroblast equipment shall be properly maintained because operation of damaged equipment at high pressure is dangerous. Staging shall be stable and correctly positioned so that the worker can hold the gun at a 60-degree angle with tip approximately 8 to 12 inches from the surface being blasted.

631-2.8.3.4.1 The hydroblast gun shall never be pointed at other personnel. The water stream is capable of severing an arm or leg.

631-2.8.3.4.2 The straight jet nozzle shall be used only in special cases such as cleaning weld seams or crevices. Caution shall be used, because the water stream will rapidly cut through paint to bare metal.

631-2.8.4 SAFETY PRECAUTIONS FOR ELECTRICALLY OPERATED POWER TOOLS. Portable power tools shall be equipped (by manufacturer or modification) with a safety throttle/lock-off device or a protected throttle switch to prevent inadvertent startup caused by tools being dropped, bumped, or stepped on. Precautions for power tools are described in the following paragraphs.

631-2.8.4.1 Inspection. Portable power tools shall be kept clean, oiled, and repaired. Tools shall be carefully inspected before use; switches shall operate, cords shall be clean and free from defects, and plugs shall be clean and sound. The switch on a tool shall be in OFF position at the time the tool is plugged into a receptacle. Tools shall be stored in a clean, dry place.

631-2.8.4.2 Grounds. Metal-cased portable tools shall be fitted with three pronged grounding plugs. Portable tools with double-insulated plastic cases are designed to be electrically safe without the use of a three-pronged grounding plug. A two-conductor flexible cable and two-pronged plug suitable for use with grounded type receptacles may be used for all such equipment. Double-insulated tools with metal gearing, and housings with two-pronged converter are also acceptable. Great care shall be used when overhauling these double-insulated tools to be sure they are properly wired.

631-2.8.4.3 Fire Hazards. Portable electric tools with brushes (sparking) shall not be used where flammable vapors, gases, liquids, or explosives are present.

631-2.8.4.4 Cord Care. Cords should not be allowed to kink, nor be left where they might be run over. Cords shall not come in contact with sharp edges, hot surfaces, oil, grease, water, or chemicals. Damaged cords shall be replaced, not repaired. Patching cords with tape is prohibited. Tools shall be stored with cords loosely coiled.

631-2.8.4.5 Extension Cords. Only three-wire extension cords with three-pronged grounding plugs and three-slot receptacles shall be used. Because a metal hull ship is a hazardous location, personnel using a portable electric device connected to an extension cord shall plug the device into the extension cord before the extension cord is inserted into a live bulkhead receptacle. Likewise, the extension cord shall be unplugged from the bulkhead receptacle before the device is unplugged from the extension cord.

631-2.8.5 SAFETY PRECAUTIONS FOR PNEUMATIC TOOLS. Safety precaution for pneumatic tools are described in the following paragraphs.

631-2.8.5.1 Personnel. Only authorized and trained personnel shall operate pneumatic tools. Operators using pneumatic tools shall wear and use necessary protective devices, including hearing protection. Personnel with arthritis, neuritis, or circulatory disease shall be examined by a Medical Officer to determine if their medical condition might be aggravated if they were to operate vibrating tools such as pneumatic hammers, chisels, tampers, riveters, or corks.

631-2.8.5.2 Inspection. Pneumatic tools shall be thoroughly inspected at regular intervals. These tools shall be kept in good operating condition, and particular attention should be given to valves, hose connections, guide clips on hammers, and chucks of reamers and drills during the inspection. All pneumatic tools should be labeled as hazardous noise sources.

631-2.8.5.3 Disconnection. Pressure shall be shut off and bled from the line before a pneumatic tool is disconnected. The tools shall be fitted with a quick-disconnect fitting and, when the tool is not in use, it shall be disconnected from its supply hose.

631-2.8.5.4 Air Hose. The air hose shall be rated for the pressure required for the tool. Leaking or defective hoses shall be removed from service. Hoses shall be routed to avoid creating a tripping hazard, particularly on ladders, steps, scaffolds, and walkways. Hoses that are run through doorways shall be protected against damage caused by the door edge. An air hose shall never be pointed at any person.

631-2.8.5.5 Compressed Air. Compressed air shall not be used to clean clothing being worn, nor shall it be used to blow off the body. Compressed air shall never be used as a power source for a projectile or to clean the deck or space where the pneumatic tool was used.

631-2.8.6 SAFETY LOCK-OFF DEVICES. Information concerning safety lock-off devices is contained in the following paragraphs.

631-2.8.6.1 Policy. It is NAVSEA policy to replace existing stocks of portable pneumatic grinders and reciprocating saws with those having a safety lock-off device which provides protection against accidental startup and to prohibit purchase of portable pneumatic grinders and reciprocating saws lacking a safety lock-off device.

631-2.8.6.2 Definition. A safety lock-off device is any operating control which requires positive action by the operator before the tool can be turned on. The lock-off device shall automatically positively lock the throttle in the OFF position when the throttle is released. Two consecutive operations by the same hand shall be required, first to disengage the lock-off device and then to turn on the throttle. The lock-off device shall be integral with the tool, shall not adversely affect the safety or operating characteristics of the tool, and shall not be easily removable. Devices such as a deadman control or quick-disconnect, which do not automatically and positively lock the throttle in the OFF position when the throttle is released, are not safety lock-off devices.

631-2.8.6.3 Action. NAVSEA shore activities shall:

a. Establish a program to replace the existing inventory of portable pneumatic grinders and reciprocating saws

with grinders and saws equipped with safety lock-off devices. This conversion shall be accomplished by purchasing such tools equipped with safety lock-off devices to replace existing grinders and saws as they are retired, except as prescribed below.

- b. Procure a supply of new grinders and saws with safety lock-off devices to be used on high-value work (nuclear, sonar dome) where inadvertent tool activation could cause significant material damage.
- c. Issue directives which specify that only portable pneumatic grinders and reciprocating saws equipped with safety lock-off devices shall be used on high-value work.
- d. Prohibit purchase of portable pneumatic grinders and reciprocating saws lacking safety lock-off devices.

631-2.8.7 SAFETY PRECAUTIONS FOR SOLVENT AND CHEMICAL CLEANING. These safety precautions apply to chemicals used to clean painted areas. Paint removers or strippers have additional special precautions.

631-2.8.7.1 Solvent Cleaning. NAVSUPPUB for Consolidated Hazardous Item List (CHIL), shall be consulted prior to selection of a particular material. Conditionally approved materials include those listed in section 5; P-D-680, Type II solvent, and solvents used for thinning approved paints. Personnel protection, fire prevention, and ventilation requirements for solvent cleaning are the same as those specified for mixing and applying paint.

631-2.8.7.2 Chemical Cleaning. A method for cleaning ferrous metal surfaces of surface ship bilges is given in section 5. It is approved for use only on surface ships at shipyards and shall not be used on submarines or at locations other than shipyards. This method shall not be used on or near aluminum.

631-2.8.7.3 Chemical Cleaning Materials. Chemical cleaning materials include sodium hydroxide (lye), sodium gluconate, and detergent. Alkaline powders and solutions constitute an extreme personnel hazard if improperly handled. Concentrating or heating solutions is ordinarily prohibited because it compounds the danger. These solutions may permanently damage or burn the eyes, severely burn skin and damage tissue, and cause death or severe injury if swallowed. Mists and dusts may severely irritate the eyes, nose, and throat.

631-2.8.7.4 Caustic Solutions. Caustic solutions shall not be prepared or stored in wide-open steel tanks. The tanks used for storage shall have a small tank opening and shall be closed during storage. Caustic solutions shall be transferred through alkali-resistant pumps and lines.

631-2.8.7.4.1 Entry into bilges containing caustic solutions is prohibited. If entry is imperative, the caustic solution shall first be removed.

631-2.8.7.5 Personnel Safety Precautions. Personnel shall be thoroughly instructed regarding the hazards of using chemical cleaning materials. Consult OPNAVINST 5100.19 Series regarding hazardous materials training programs. Personnel working in areas where chemical solutions are being used, prepared, or transferred shall be dressed in clothing impervious to the chemicals. This includes chemical safety goggles. Safety showers and eye-wash fountains shall be provided near work areas where caustic solutions are prepared, used, or stored.

631-2.8.8 SAFETY PRECAUTIONS FOR PAINT STRIPPERS AND REMOVERS. Paint strippers and removers present one or more of the following hazards: fire, anesthetic, toxic, or caustic. Accident investigation results indicate that extreme handling precautions are required because of these hazards and the number of different formulations involved.

631-2.8.8.1 General. Paint strippers containing phenol or cresol are considerably more toxic than most shipboard paints or solvents. Both phenol and cresol are readily absorbed through the skin and may cause serious illness, or even death, if not washed off promptly. In the case of phenol-containing paint removers (for example, those in accordance with MIL-R-46116, MIL-R-81924, and MIL-R-81903), personnel protection includes, as a minimum solvent-resistant synthetic rubber gloves and boots, solvent-resistant suits or coveralls, and rubber-framed goggles and face shields. Full eye protection with respirators or air-supplied hoods is mandatory whenever the atmospheric limits for the air contaminants are exceeded. Personnel not essential to the paint stripping operation should be evacuated.

631-2.8.8.2 Accidental Contact. Clothing wetted with the paint remover shall be removed immediately and not reworn until laundered. If paint remover contacts the skin, flush off immediately with large quantities of water. If remover enters the eyes, flush with running water for at least 15 minutes with the eyelids held open. Medical attention shall be obtained. Personnel using these paint removers shall have ready access (10 seconds) to a safety shower and eyewash fountain.

631-2.8.8.3 Prohibited Use. Paint strippers or removers shall not be used on fiberglass-reinforced plastic laminates, other plastics, electrical insulators (other than ceramic), or other materials which may be damaged by the stripper, unless specific NAVSEA approval has first been obtained. Caustic strippers shall not be used on aluminum, magnesium, or zinc. Applications of paint strippers or removers aboard submarines is allowed only when paragraph 631-2.8.8.3.1 requirements are followed. Deviation to paragraph 631-2.8.8.3.1 requirements is prohibited, unless prior approval has been obtained from NAVSEA.

631-2.8.8.3.1 Methylene chloride, a component in most if not all paint removers, is a suspected carcinogen, and if this product is to be used at all, must be handled very carefully. Exposure to its vapors must be carefully controlled, especially in confined spaces. In any case, the local industrial hygienist shall determine its safe use. In addition, methylene chloride vapors in the atmosphere can contaminate vented pure water tanks. The use of methylene chloride-based remover is allowed only when the following requirements are observed:

- a. Paint remover is only to be applied when hand and mechanical means will leave the base material in an unacceptable condition (e.g., when preparing for inspection of welds or base metal fracture). Approval of each use shall be by the senior manager of the cognizant shipyard engineering organization.
- b. The use of paint remover shall be done only on a small scale, four square feet maximum in non-propulsion space and two square feet maximum in propulsion space, respectively, at any one time.
- c. Adjacent shipboard structures and equipment, where paint remover is to be used, shall be protected from accidental spills of the remover by masking and drop cloths.
- d. Temporary ventilation shall be installed before, during and after remover application, to remove noxious fumes.
- e. Aboard submarines, CO₂ scrubbers shall not be in use when the remover is being applied.
- f. Personnel protective equipment, such as solvent-impermeable coveralls, gloves, and supplied-air respirator, shall be worn when the remover is being applied.
- g. Removers shall be brushed on, rather than sprayed on, to minimize fumes in the air. Use of an aerosol gas-ket remover is not permitted.
- h. Paint remover shall not be permitted to contact any shipboard rubber parts such as rubber hoses or rubber sound mounts.
- i. Hot work shall be suspended in the spaces, where remover fumes are present.

631-2.8.8.4 Personnel Protective Procedures. Paint strippers or removers shall not be used until personnel protective guidance for the specific proposed use has been obtained from an NAVENPVNTMEDU or the medical treatment facility's Occupational Health Service. Other paint removal methods shall be used if personnel protective guidance cannot be practicably implemented for chemical stripping.

631-2.8.8.5 Pollution Control. Caustics, paint strippers, and solvents are hazardous materials. They shall be disposed of in accordance with **NSTM Chapter 593, Pollution Control**.

631-2.8.8.6 Approval of Materials. Only strippers/removers which have been specifically approved in accordance with NAVSEA S9510-AB-ATM-010/(U) for any application within occupied areas of the submarine shall be used. NAVSEASYSCOM (SEA-05V22) shall be contacted for specific guidance in this regard pertaining to the submarine materials review process, documentation requirements and placement of tested materials in the Nuclear Powered Submarine Atmosphere Control Manual.

SECTION 3

PAINT EQUIPMENT, GAUGES, AND MATERIALS

631-3.1 INTRODUCTION

631-3.1.1 The selection of the proper equipment and materials for any painting job requires a general knowledge of the equipment and materials needed to do the job correctly. This section describes the different tools that are available for the application of paints and the tools that are used for testing. Also, this section provides information on the requisition, storage, and testing of paints.

631-3.2 PAINT EQUIPMENT

631-3.2.1 GENERAL. Tools used for the application of paint shall be of first quality and maintained in perfect working condition at all times. The types of tools and their care and maintenance are described in the following paragraphs.

631-3.2.2 PAINT BRUSHES. Brushes are identified by the type of bristle used; natural, synthetic, or a mixture of each. The types of brushes available through the National Supply System are listed in [Table 631-3-1](#). The various types of bristles, their uses, and their advantages and disadvantages are described in the following paragraphs.

631-3.2.2.1 Chinese Hog Bristles. Chinese hog bristles are the finest of the natural bristles because of their length, durability, and resiliency. Hog bristle has a unique characteristic in that the bristle end forks out (flags) like a tree branch and permits more paint to be carried on the brush. In addition, the hog bristle flagging leaves finer brush marks which flow together readily and result in a smooth finish.

631-3.2.2.2 Horsehair Bristles. Horsehair bristles are used in inexpensive brushes and are an unsatisfactory substitute for hog bristles. The ends of the horsehair bristles do not flag and quickly become limp. They also hold far less paint and do not spread the paint as well. Brush marks left in the applied coating tend to be coarse and do not level as smoothly.

Table 631-3-1. BRUSHES AND ROLLERS

Identification	Applicator Width (in.)	NSN
Flat paintbrush	1	8020-00-899-7920
Flat paintbrush	3	8020-00-597-4770
Flat paintbrush	4	8020-00-597-4784
Flat paintbrush	5	8020-00-597-4781
Paint applicator	7	8020-00-597-4759
Paint applicator	9	8020-00-689-5379
Paint roller tray	N/A	8020-00-753-4911
Paint roller, replacement	7	8020-00-753-4914
Paint roller, replacement	9	8020-00-753-4915
Roller covers	7	8020-00-682-6489
Roller covers	9	8020-00-682-6491
Roller grid for 5-gallon pails	N/A	8020-00-721-9360

NOTE

Some brushes contain a mixture of hog bristle and horsehair and their quality depends upon the percentage of each type used.

631-3.2.2.3 Other Animal Hair Brushes. Animal hair is used in fine brushes for special purposes. Badger hair, for example, is used for a particularly good varnish brush. Squirrel and sable are ideal for striping, lining, lettering, and freehand art brushes.

631-3.2.2.4 Nylon Brushes. Nylon is the most common synthetic used in paint brushes. By artificially exploding the ends and kinking the fibers, manufacturers have increased the paint load nylon can carry and have reduced the coarseness of nylon brush marks. Nylon is almost always superior to horsehair. Nylon brushes are recommended for use with latex paint because wear does not cause any appreciable swelling of nylon bristles.

631-3.2.2.4.1 The fact that nylon is a synthetic substance makes nylon brushes unsuitable for applying lacquer, shellack, many creosote products, and any other coating that would soften or dissolve nylon bristles.

631-3.2.3 BRUSH CARE AND MAINTENANCE. Before using, rinse brushes with paint thinner. Brushes that are to be reused the following day need to be marked for white, light colors, or dark colors. Brushes should be suspended by the handle in a closed container, with the bristles immersed in paint thinner or linseed oil to just below the bottom ferrule. The weight of the brush should not rest upon the bristles.

631-3.2.3.1 Brushes that are not to be reused immediately shall be cleaned with thinner or some other solvent (at least three cleanings), and then washed with detergent and water. Brushes shall be stored suspended from racks by the handle or wrapped in paper and stored in a flat position.

631-3.2.4 PAINT ROLLERS. The selection of a paint roller for a job depends upon the type of paint being used and the surface to be coated. Paint rollers and their covers are described in the following paragraphs.

631-3.2.4.1 Roller Description. A paint roller is a cylindrical sleeve or cover which slips onto a rotatable cage. The inside diameter of the cover is 1-1/2 to 2-1/4 inches. In length, covers are 3, 4, 7, and 9 inches. Special rollers are available in lengths from 1-1/2 to 18 inches. The types of rollers that are available through the National Supply System are listed in [Table 631-3-1](#).

631-3.2.4.2 Types of Roller Covers. Proper paint application depends upon the selection of a cover with the desired fabric and fabric thickness (nap length). Selection is based on the type of paint to be used and the smoothness or roughness of the surface to be painted. The fabrics used in roller covers are:

- a. Lambs wool (pelt) is the most solvent-resistant type of material used and is available in nap length up to 1-1/4 inches. Lambs wools is recommended for application on semi-smooth and rough surfaces; it mats badly in water and is not recommended for water-base paints.
- b. Mohair is made primarily of angora hair. It is solvent-resistant and is supplied in 3/16- to 1/4-inch nap lengths. Mohair is recommended for synthetic enamels and for use on smooth surfaces, and can be used with water-base paints.
- c. Dynel is a modified acrylic fiber which has excellent resistance to water. It is best for application of conventional water-base paints and solvent-base paints, except those which contain strong solvents such as ketones. Dynel is available in a range of nap lengths from 1/4- to 1-1/4 inches.
- d. Dacron is a synthetic fiber which is somewhat softer than Dynel. It is best suited for exterior oil or latex paints. Dacron is available in nap lengths ranging from 5/16- to 1/2-inch.
- e. Rayon roller covers are not recommended because of poor results generally obtained. In addition to other disadvantages, rayon mats badly in water.

631-3.2.5 PAINT SPRAY GUN. A conventional paint spray gun is a mechanical means of bringing air and paint together. The mixing of air with the paint atomizes (breaks up) the paint into a spray either before or after it is propelled through the air cap. The spray equipment authorized for each ship is contained in the Revised Master Allowances List.

631-3.2.5.1 General. Each spray gun consists of the gun body assembly and the removable spray head assembly.

631-3.2.5.2 Spray Gun Body Assembly. The principal parts of a conventional spray gun are illustrated in [Figure 631-3-1](#) and described in the following listing:

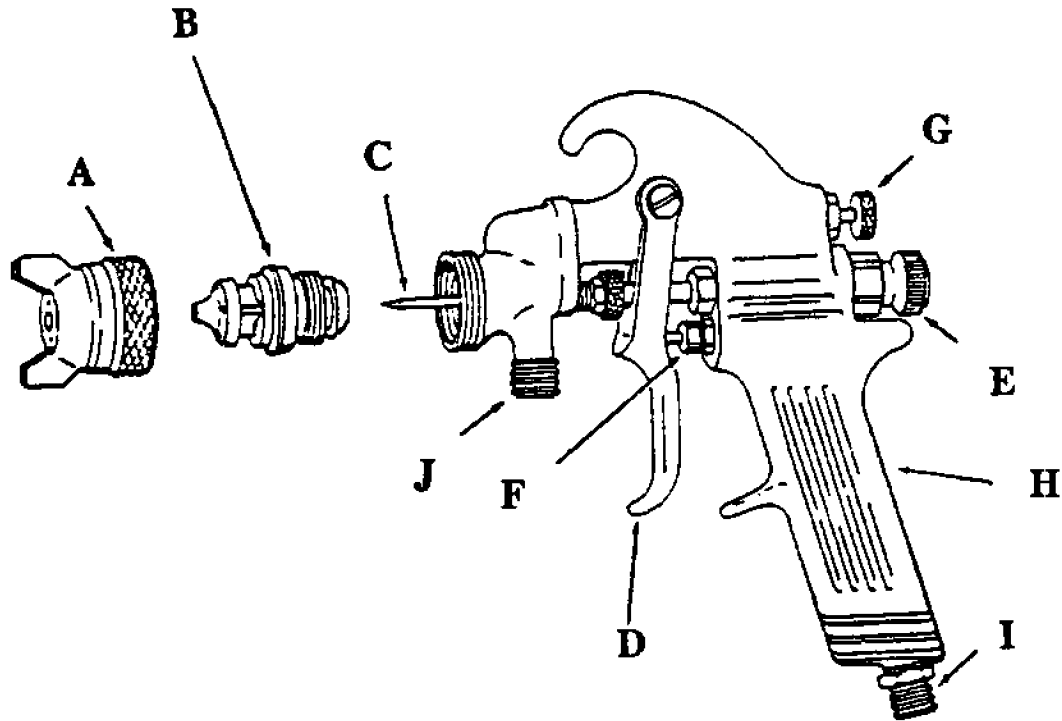


Figure 631-3-1 Conventional Spray Gun

- A. **Air nozzle or cap:** The air nozzle directs the compressed air into the stream of paint. The air atomizes the paint at this point and directs the flow of particles onto the surface.
- B. **Fluid nozzle or tip:** The fluid nozzle regulates the amount of paint released and directs the paint into the stream of compressed air.
- C. **Fluid needle:** The needle starts or shuts off the fluid flow through the fluid nozzle. Select the fluid nozzles and needles in pairs, as they shall be the same size to operate correctly.
- D. **Trigger:** The trigger operates the air valve and the fluid needle.
- E. **Fluid adjustment screw:** The fluid adjustment screw controls the fluid needle to allow more or less paint to get to the fluid tip.
- F. **Air valve:** The air valve controls the rate of airflow through the gun to the nozzle.
- G. **Side port control:** The side port control regulates the supply of air to the air nozzle and it determines the size and shape of the spray pattern.
- H. **Gun body and handle:** The gun body is the part of the equipment the painter holds to operate the spray gun.
- I. **Air inlet:** The air inlet is at the bottom of the handle and is connected to the airhose.
- J. **Fluid inlet:** The fluid inlet is an opening below the fluid needle and is connected to the fluid hose.

631-3.2.5.3 Types of Spray Guns. Most types of conventional spray guns that are available to shipyards and ships are assembled with a pressure tank equipped for separate control of paint, and with adjustable atomizing air pressures to obtain a satisfactory spray pattern. Some nozzle combinations will perform better than others. Some

assemblies clog at the air cap during continuous spraying of fast-drying paints (for example, vinyls) and may require cleaning too frequently. Clogging may produce too small a spray pattern or may require spraying too close to the surface.

631-3.2.5.3.1 Information regarding recommended air cap and fluid tip combination for specific paints can be found in equipment manufacturers's literature. Naval Ship Systems Engineering Station (NAVSSSES) should be contacted for assistance with any problems which cannot be resolved locally.

631-3.2.6 CONVENTIONAL SPRAY PAINTING EQUIPMENT CARE AND MAINTENANCE. Spray painting equipment must be carefully maintained to achieve optimum performance and life. Spray guns, paint containers, and hoses shall be thoroughly cleaned after use.

CAUTION

Never soak the assembled gun in paint thinner because it has a detrimental effect upon the packing around the fluid valve, as well as on the grease and oil in the trigger action. Do not use caustic alkaline solutions for cleaning spray guns. They destroy aluminum alloys used in gun bodies and parts.

631-3.2.6.1 Spray Gun Cleaning. When using a pressure feed tank, release the pressure from the tank, hold a cloth over the air cap, and pull the trigger. This forces the material back into the tank. Then remove the paint hose from the gun and run solvent through the hose. Dry out the hose with air. Spray some solvent through the gun. Remove air cap and wash off the fluid tip with solvent. Repeat until all paint residuals are removed from the cup and spray gun. Clean air cap and replace on gun. Clean out tank and reassemble for future use.

When using a cup gun, remove the cup, then hold a cloth over the openings in the air cap, reduce the pressure to 1-15 lb/in², direct the gun siphon tube toward the paint container and pull the trigger. This forces paint back into the container. Empty cup of paint and replace with small quantity of solvent. Spray solvent in the usual way, remove air cap, and wash off fluid tip with solvent. Repeat until all paint residuals are removed from the cup and spray gun. Clean air cup and replace on gun.

631-3.2.6.2 Air Cap Cleaning. Clean air cap by immersing in solvent. If small holes become clogged, soak in solvent. If reaming is still necessary, use match stick, broom straw, or any other soft implement. Digging out the holes with a wire or nail may permanently damage the cap.

631-3.2.6.3 Spray Gun Lubrication. Spray guns require occasional lubrication. The fluid needle packing should be removed and softened with oil, and fluid needle shank should be coated with grease or petrolatum. Use a few drops of light oil on all moving parts. Most spray guns are provided with oil holes for these parts.

631-3.2.7 AIRLESS SPRAY PAINTING. Airless spray painting is done with the use of hydraulic pressure. The equipment operates on a different principle than conventional equipment. An air compressor operates a hydraulic pump which causes paint atomization by forcing it through a specially shaped orifice at pressures up to 4500 lb/in². NEVER attempt to clean an airless fluid hose as you would a conventional air atomized system. The extremely high working pressures will drive paint through the skin into the bloodstream and cause serious bodily injury or even death with some materials.

631-3.2.7.1 Airless spraying usually permits the use of products with a higher viscosity; less thinning is required, better film build is obtained, and production is increased. The need for a single hose leading into the gun makes airless spray equipment lighter to handle and less fatiguing. The reduction of overspray offers two other advantages, cleanup is easier and masking is minimized.

631-3.2.8 AIRLESS SPRAY EQUIPMENT CARE AND MAINTENANCE. All fluid connections should be tightened before starting the hydraulic pump. High-pressure fluid hose shall be checked for possible damage through kinking, bending, or abrasion. Avoid careless handling of the spray gun, especially when the nozzle has been removed. Relieve the fluid pressure before disconnecting the hose to the airless spray gun.

631-3.2.9 METAL SPRAY. Improved corrosion control and reduced shipboard maintenance are achieved by metal-type coatings (aluminum) that are applied by the spray process. They provide electrochemical (cathodic) protection to surfaces exposed to the marine atmosphere and in proximity to dissimilar metals. Detailed descriptions of this process are contained in DOD-STD-2138.

631-3.3 PAINT THICKNESS GAUGES

631-3.3.1 GENERAL. Paint thickness is measured in terms of wet film thickness (WFT) and dry film thickness (DFT). The WFT measurements are useful in monitoring on-site paint applications. The DFT measurements determine the final barrier film obtained for preservation. The gauges used for the measurements of WFT and DFT are described in the following paragraphs.

631-3.3.2 MINIMUM FILM THICKNESS REQUIREMENTS. A summary of the minimum film thickness requirements for the often-used paints in the National Supply System is given in [Table 631-3-2](#) and [Table 631-3-3](#). These tables include supplementary data for the spreading rates as theoretical and practical coverage. The figures presented in the practical coverage columns reflect a 30-percent application loss which should be used in work calculations and materials cost estimates.

631-3.3.2.1 When a measurement of paint thickness is specified, surfaces subjected to immersion service, including bilges, the minimum dry film thickness shall be determined by the average of not less than 10 random thickness measurements made with a suitable and properly calibrated dry film thickness gage for each 1,000 square foot area (or less) of painted surface. No single dry film reading shall be below the total minimum dry film thickness specified for the coating system being used. For other surfaces, a minimum of five DFT measurements shall be recorded for every 1,000 square feet of painted surface. The lowest reading and the average of these readings shall be the official recorded values.

631-3.3.3 WFT MEASUREMENTS. WFT gauges are used to check freshly applied coatings. WFT multiplied by the decimal equivalent of the percentage of solids by volume gives an estimate of the DFT which will remain after the solvent has evaporated. Wet film gauges to be used are described in the following paragraphs. WFT determinations are estimates and cannot be construed as precise measurements particularly with fast-evaporating solvent-containing coatings since these begin to shrink from solvent loss as soon as they are applied. However, they are very beneficial for the applicator if used properly.

631-3.3.3.1 Interchemical WFT Gauge. The interchemical WFT gauge consists of an eccentric center wheel attached to two concentric running wheels. Rolling of the gauge results in the central measuring wheel dipping into the coating. The point at which the film first touches the center wheel measures the thickness of the film, which can be read on the thickness (mils) scale provided on one of the running wheels. The range of the particu-

lar gauge selected for use should be one in which the measured film thickness falls within the middle 80 percent of each scale. The gauge is available in the ranges given in [Table 631-3-4](#).

631-3.3.3.2 Nordson WFT Gauge. The Nordson WFT gauge has several legs, with each of the inner legs somewhat shorter than the two outer legs. The two end legs define the plane of application and penetrate through the wet film to the substrate. Consequently, some of the legs will dip into the coating while others will not touch it. The leg which is just wetted by the coating indicates the WFT. An example of the use of this type of gauge is shown in [Figure 631-3-2](#). To measure WFT correctly:

Table 631-3-2. FILM THICKNESS AND SPREADING RATE FOR UNTHINNED FORMULA PAINTS

Formula Number ²	Minimum Film Thickness (mils)		Theoretical Coverage (sq ft/gal/coat)	Practical Coverage (sq ft/gal/coat)
	WFT	DFT		
30	2.9	1.5	556	389
34	8.3	5.0	193	135
109	3.1	1.5	512	358
111	2.9	1.5	549	384
120	8.8	1.5	182	127
121	3.3	2.0	489	342
124, 125 ¹ and 126	2.9	1.5	545	381
129	3.7	2.0	431	302
150	5.2	3.0	312	218
151	5.4	3.0	297	207
152	5.5	3.0	294	206
153	5.4	3.0	296	207
154	5.4	3.0	297	208
155	5.4	3.0	300	210
156	4.9	3.0	326	228
157	5.4	3.0	297	207

Table 631-3-3. FILM THICKNESS AND SPREADING RATE FOR SELECTED PAINTS IN THE NATIONAL SUPPLY SYSTEM

Formula Number ²	Minimum Film Thickness (mils)		Theoretical Coverage (sq ft/gal/coat)	Practical Coverage (sq ft/gal/coat)
	WFT	DFT		
TT-P-28	7.0	0.5	230	161
TT-V-119	3.4	1.5	470	329
TT-E-489	4.4	1.5	366	256
TT-E-490	3.3	1.5	492	344
TT-P-645	4.2	1.5	385	270
TT-P-1757	3.7	1.5	428	300
MIL-E-24635	3.3	1.5	492	344

Table 631-3-4 INTERCHEMICAL WFT GAUGE

Range (mils)	Smallest Graduations (mils)
0 to 0.4	0.02
0 to 1	0.05
0 to 2	0.1
0 to 4	0.2
2 to 12	0.5
10 to 30	1.0
20 to 60	2.0

1. Read WFT immediately after paint application before the solvents have evaporated.
2. Use the WFT gauge on a flat surface. Both ends must be firmly touching the surface.
3. On a vertical surface, such as a bulkhead, hold the gauge in a north-south position (vertical) with the longer legs at the top. This prevents the paint from running down over the longer legs and giving a false reading.
4. On a pipe, place the gauge along the length. Both legs must touch the surface.
5. Lift the gauge from the surface without sliding. Slipping or sliding will give a false reading, extra paint will be picked up on the legs.
6. Use only a clean, dry gauge. Clean the gauge after each readings. Dirt on the bottoms of the legs adds to their length and gives lower readings.

631-3.3.4 DFT MEASUREMENTS. Minimum DFT for the coatings listed in [Table 631-3-2](#) and [Table 631-3-3](#) should be determined with one of the DFT gauges (or equal) described in the following paragraphs. Commonly used gauges are illustrated in [Figure 631-3-3](#) and [Figure 631-3-4](#).

631-3.3.4.1 General Electric Type B Thickness Gauge. The General Electric Type B thickness gauge is a rugged, reasonably portable instrument operating from a 115-volt, 60-Hz power supply. The gauge operates on a magnetic principle and can be used to measure coatings only on a magnetic surface. The instrument is fast and easy to use, and can be used on slightly curved surfaces as well as on flat surfaces. It is necessary to standardize the scale with a foil of known thickness on a bare area of the same thickness and type of surface as the one on which the measurement is being made, because different surfaces will give different readings.

631-3.3.4.1.1 Measurements shall not be made close to edges and corners, as this will cause variations in the readings. The accuracy of the readings vary with the thickness of foil used to standardize the instrument. For best results, the standardizing foil shall be close to the actual thickness of the paint film being measured.

631-3.3.4.2 Elcometer Thickness Gauge. The Elcometer thickness gauge has different ranges available and is a light, portable pocket size instrument. This gauge is operated by means of the variation in magnetic force between the metal surface and a self-contained permanent magnet. No outside power source is necessary. Measurements can be made on slightly curved surfaces.

631-3.3.4.2.1 To operate the Elcometer thickness gauge, it is necessary to first standardize the dial over a bare area of the same type and thickness of metal as that on which the coating is to be measured. It is important for

accuracy to hold the meter in the same place when taking the measurements, as the gauge is then set to zero. The results obtained will be satisfactory for most purposes for which field measurements are made, providing the necessary precautions for use are taken.

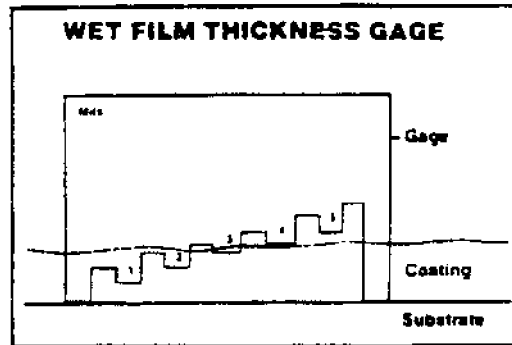


Figure 631-3-2 WFT Gauge

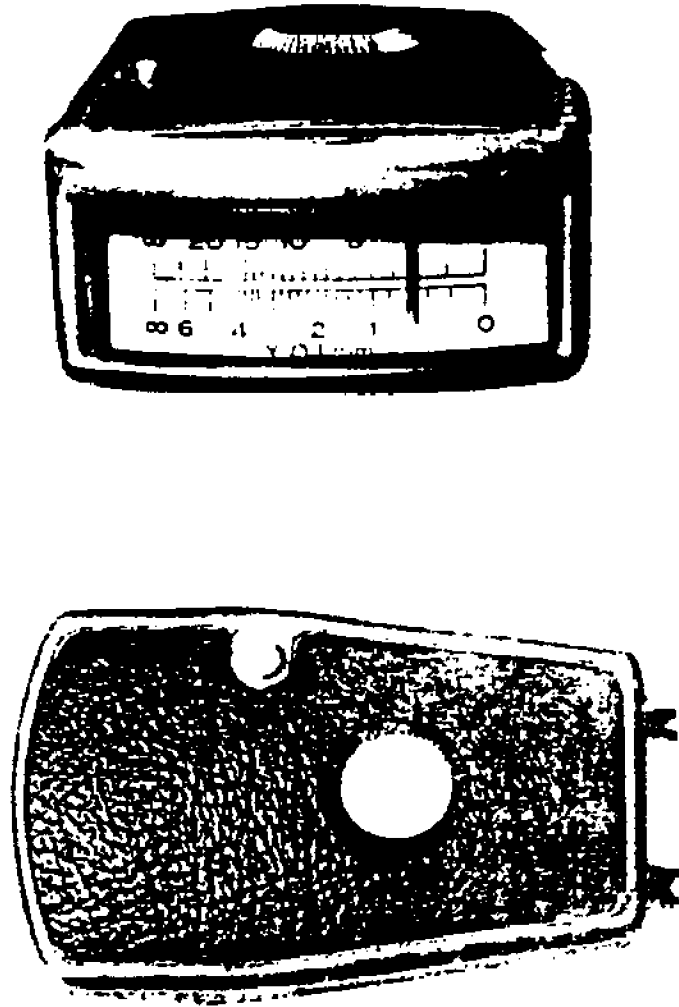


Figure 631-3-3 Dual Probe Magnetic DFT Gauge (Elcometer Type)



Figure 631-3-4 Single Probe Magnetic DFT Gauge (Mikrotest Type))

631-3.3.4.3 General Electric Permanent Magnet Thickness Gauge. The General Electric permanent magnet thickness gauge is a portable, self-contained gauge with a dual scale. The low scale ranges from 0 to 7 mils and the high scale ranges from 1 to 60 mils. The gauge is also provided with a go-no-go-feature which can be set for a minimum and maximum paint thickness.

631-3.3.4.4 Mikrotest Thickness Gauge. In the Mikrotest thickness portable gauge, a small magnet is attached to one end of a balance which is at equilibrium; the magnet is connected through a spiral spring with a micrometer screw. To measure DFT, the spiral spring of the gauge is stretched by turning the micrometer screw until the magnet is pulled away from the coated surface. The coating thickness can then be read from the calibrated disk or obtained from a calibration curve.

631-3.3.4.5 Dermatron Electromagnetic Thickness Gauge. The Dermatron electromagnetic thickness gauge and other Eddy-current type thickness gauges are electronic instruments that measure variations in impedance of Eddy-current-inducing coil by paint coating thickness variations. Gauges of this type can be used only if the electrical conductivity of a coating differs significantly from that of the substrate. Typical measurement applications involve an organic coating over aluminum or corrosion-resistant steel.

631-3.3.4.6 Tooke Coating Inspection Gauge. The Tooke coating inspection gauge is an optical thickness gauge. It is used to measure the thickness of different colored individual paint coats or can be used when non-destructive gauges cannot be used. A cut is scribed through the film and measurements are made by means of a calibrated microscope eyepiece. After the measurements, the scribed marks shall be repainted.

631-3.4 PAINTS AND PAINT MATERIALS

631-3.4.1 GENERAL. Only paints and paint materials that are in accordance with Navy standard formulas and specifications, or approved by NAVSEA, shall be used on board naval ships. The Revised Master Allowance List contains the paint allowances for all naval ships. Paints and paint materials covered by formula designations are listed in [Table 631-3-5](#). Included in this table are National Stock Numbers (NSN) and specifications. Paints and paint materials covered by specifications, but not by formula designations, are listed in [Table 631-3-6](#). **ONLY PAINT THAT COMPLIES WITH ALL LOCAL, STATE AND FEDERAL ENVIRONMENTAL REGULATIONS SHALL BE PROCURED AND APPLIED.**

631-3.4.2 PAINT REQUISITION. Paint requisitions shall be submitted only for paints presented in this section. The formula or specification numbers of the paints to be ordered shall be stated on the requisition. If only the formula number is given, the publication date of this chapter shall also be given.

631-3.4.2.1 If a type of paint is needed that is not covered in this section, the paint shall be specified on the requisition along with its intended use.

631-3.4.3 RECEIPT OF UNSATISFACTORY PAINT. Ships receiving a standard paint that is unsatisfactory in quality or quantity should immediately determine the defects and their extent. If possible, the cause of the defects should be determined and the findings reported to NAVSSES, to the Laboratory Division of the nearest Naval Shipyard, or to the Paint Branch, Annapolis Laboratory of the David Taylor Research Center, with a copy to the Naval Sea Systems Command (NAVSEA). In the case of quality defects, an original unopened container of the material should be submitted for laboratory examination with the report of findings. For identification, the invoice number under which the paint was received should be stated in the correspondence. The manufacture date of each kind of ready-mixed paint is stamped on the paint container and shall be referred to in reporting unsatisfactory paint.

631-3.4.4 RECEIPT OF SPECIAL PAINT. Ships receiving special paint (paints other than those presented in this section) should, if practical, compare it with a standard paint intended for the same purpose and submit a complete report to NAVSEA covering the results obtained. See section 6 for reporting requirements.

Table 631-3-5 MATERIALS WITH FORMULA DESIGNATIONS

Formula Number	Coating	NSN's and Container Size	Specification
6N35-2	Blue identification primer	No NSN available	MIL-P-24351
30	White enamel	8010-00-286-7744 (1 gal) 8010-00-286-7745 (5 gal)	DOD-E-1115
38*	Black striping 17038		
39*	Green striping 14062		
40*	Red striping 11105		
41*	Brown striping 10075		
42*	Yellow striping 13538		
43*	Blue striping 15123		
49	Cherry stain	8010-00-165-4422 (1 qt)	TT-S-711
50	Dark mahogany stain	8010-00-281-2075 (1 gal)	TT-S-711
51	Dark oak stain	8010-00-165-8628 (1 qt) 8010-00-281-2072 (1 gal)	TT-S-711
52	Light oak stain	8010-00-597-8226 (1 qt) 8010-00-166-0746 (1 gal)	TT-S-711
54	Walnut stain	8010-00-597-8225 (1 gal)	TT-S-711
67	Slate color putty	8010-00-275-8097 (1 gal)	TT-P-791, Type 2
84	Zinc molybdate primer	8010-01-285-1329 (1 gal) 8010-01-285-1328 (5 gal)	TT-P-645
102	Zinc dust paint	8010-00-290-6645 (5 gal)	MIL-P-15145
111	Light gray enamel	8010-00-285-4858 (1 qt) 8010-00-285-4868 (1 gal) 8010-00-285-4869 (5 gal)	MIL-E-15090
121	Anti-fouling, red (vinyl)	8010-01-286-7050 (5 gal)	MIL-P-15931
124	White (chlorinated alkyd)	8010-01-344-5089 (1 gal) 8010-01-344-5100 (5 gal)	DOD-E-24607
125	Pastel green (chlorinated alkyd)	8010-01-344-5090 (1 gal) 8010-01-344-5101 (5 gal)	DOD-E-24607
126	Bulkhead gray (chlorinated alkyd)	8010-01-344-5091 (1 gal) 8010-01-344-5102 (5 gal)	DOD-E-24607
129	Anti-fouling, black (vinyl)	8010-01-286-7051 (5 gal)	MIL-P-15931
150	Green primer	8010-01-380-2362 (2 gal kit) 8010-01-380-2389 (10 gal kit)	MIL-P-24441/ 29 Type IV
151	Haze gray	8010-01-380-2435 (2 gal kit) 8010-01-380-2388 (10 gal kit)	MIL-P-24441/ 30 Type IV
152	White	8010-01-380-2448 (2 gal kit) 8010-01-380-2343 (10 gal kit)	MIL-P-24441/ 31 Type IV
153	Black, R _o 1.8	8010-01-380-2375 (2 gal kit) 8010-01-380-2456 (10 gal kit)	MIL-P-24441/ 32 Type IV
154	Black, R _o 3.6	8010-01-380-2359 (2 gal kit) 8010-01-380-2390 (10 gal kit)	MIL-P-24441/ 33 Type IV
155	Black, R _o 6.0	8010-01-380-2414 (2 gal kit) 8010-01-380-2441 (10 gal kit)	MIL-P-24441/ 34 Type IV
156	Red	8010-01-380-2345 (2 gal kit) 8010-01-380-2383 (10 gal kit)	MIL-P-24441/ 35 Type IV
157	Gray No. 50	8010-01-380-2408 (2 gal kit) 8010-01-380-2434 (10 gal kit)	MIL-P-24441/ 36 Type IV

Table 631-3-5 MATERIALS WITH FORMULA DESIGNATIONS -

Continued

Formula Number	Coating	NSN's and Container Size	Specification
158	Yellow	8010-01-380-2407 (2 gal kit)	MIL-P-24441/ 37 Type IV
160	Black	8010-01-380-2337 (2 gal kit)	MIL-P-24441/ 38 Type IV
161	Yellow	8010-01-380-2391 (2 gal kit)	MIL-P-24441/ 39 Type IV
162	Red	8010-01-380-2415 (2 gal kit)	MIL-P-24441/ 40 Type IV
			MIL-P-24441/8
150 Ty III	Green primer	8010-01-347-0916 (2 qt) 8010-01-350-4742 (2 gal) 8010-01-302-3608 (10 gal)	MIL-P-24441/20
151 Ty III	Haze gray	8010-01-350-4741 (2 gal) 8010-01-302-6838 (10 gal)	MIL-P-24441/21
152 Ty III	White	8010-01-350-4743 (2 gal) 8010-01-302-3606 (10 gal)	MIL-P-24441/22
153 Ty III	Black R _o 1.8	8010-01-350-4744 (2 gal) 8010-01-302-3604 (10 gal)	MIL-P-24441/23
154 Ty III	Dark gray R _o 3.6	8010-01-350-6256 (2 gal) 8010-01-302-3605 (10 gal)	MIL-P-24441/24
155 Ty III	Dark gray R _o 6.0 topcoat	8010-01-302-7058 (10 gal)	MIL-P-24441/25
156 Ty III	Red topcoat	8010-01-350-4745 (2 gal) 8010-01-302-3607 (10 gal)	MIL-P-24441/26
157 Ty III	Light gray topcoat	8010-01-302-3609 (10 gal)	MIL-P-24441/27
184	Black R _o 1.8 epoxy	8010-01-212-5493 (5 gal)	DOD-P-24631/1
185	Dark gray R _o 3.6 epoxy	8010-01-214-0373 (5 gal)	DOD-P-24631/2
186	White	8010-01-212-5494 (5 gal)	DOD-P-24631/3
EC 2216	Flexible Epoxy Cavitation Resistant	8010-00-145-0530 (1 qt kit) 8010-00-145-0432 (1 pt kit)	3M

NOTE

Where F-150 series paints are indicated, this refers to coatings covered by specification MIL-P-24441. Unless otherwise directed by NAVSEA, MIL-P-24441, Type IV paints are to be applied to the same dry film thickness as Type III paints, but in two coats (i.e., If three coats of Type III are applied to 10 mils total dry film thickness, Type IV would be applied in two coats at 10 mils total dry film thickness.)

Formulas 30, 39, 40, 41, 42 and 43 have been superseded by high gloss enamels qualified to MIL-PRF-24635 in the required Fed Std No. 595 colors.

Table 631-3-6 MATERIALS WITHOUT FORMULA DESIGNATIONS

Material	Specification	NSN's
Anti-sweat compound	Hempels Anti Condens 617US	8010-01-434-2104 (1 gal) 8010-01-385-7578 (5 gal)
Anchor chain paint	Ameron PSX 700 or equal	Safety yellow 8010-01-432-2614 (5 gal kit) Red 8010-01-432-2615 (1 gal kit) Blue 8010-01-432-1206 (1 gal kit) Black 8010-01-432-2617 (5 gal kit) White 8010-01-432-2616 (1 gal kit)
Caulking compound, knife or gun application (metal and wood)	TT-C-001796, Type 1	8030-00-160-6899 (1/2 pt) 8030-00-577-4740 (1/2 gal cart) 8030-00-243-0956 (1 gal) 8030-00-550-8652 (5 gal)
Caulking compound, knife and caulking iron application (metal only)	TT-C-001796, Type 2	8030-00-753-4982 (RO) 8030-00-297-0600 (1 qt) 8030-00-550-8628 (1 gal)
Canvas Preservative:	TT-P-595	
Haze gray		8030-00-550-5906 (1 gal) 8030-00-550-5905 (5 gal)
Deck gray		8030-00-281-2347 (1 gal) 8030-00-281-2714 (5 gal)
Olive drab		8030-00-281-2346 (5 gal)
White		8030-00-550-8017 (1 gal) 8030-00-285-6543 (5 gal)
Cleaning compound, solvent emulsion cleaner	MIL-C-22230	6850-00-292-9700 (5 gal) 6850-00-292-9701 (55 gal)
Cleaning compound, steam	P-C-437	6850-00-664-7056 (25 lb) 6850-00-256-0157 (125 lb) 6850-00-256-0158 (400 lb)
Coating compound thermal insulating (intumescent):	MIL-C-46081	
Pastel green		8010-00-228-0620 (1 gal) 8010-00-228-0621 (5 gal)
Bulkhead gray		8010-00-228-0622 (1 gal) 8010-00-228-0623 (5 gal)
Green gray		8010-00-228-0624 (1 gal) 8010-00-228-1425 (5 gal)
Yellow gray		8010-00-228-0626 (1 gal) 8010-00-228-0627 (5 gal)
Pearl gray		8010-00-228-0628 (1 gal) 8010-00-228-0631 (5 gal)
Pastel blue		8010-00-228-0632 (1 gal) 8010-00-228-0649 (5 gal)
Coating compound, fire protective, Ocean 634 and Ocean 9788		634 9Q-8010-00-220-5971 9788 9Q-8010-00-220-5968
Corrosion preventive compounds:		
Solvent cutback, cold application, thin film	MIL-C-16173, Grade 1 (hard film)	8030-00-231-2345 (1 gal) 8030-00-244-1299 (5 gal) 8030-00-244-1300 (55 gal)

Table 631-3-6 MATERIALS WITHOUT FORMULA DESIGNATIONS -

Continued

Material	Specification	NSN's
	MIL-C-16173, Grade 2 (soft film)	8030-00-244-1297 (1 gal) 8030-00-244-1298 (1 gal) 8030-00-244-1295 (55 gal)
	MIL-C-16173, Grade 3 (soft film, water displacing)	8030-00-244-1296 (1 gal) 8030-00-244-1293 (5 gal) 8030-00-244-1294 (55 gal)
	MIL-C-16173, Grade 4 (transparent, nontacky film)	8030-00-062-5866 (1 gal) 8030-00-526-1605 (5 gal) 8030-00-526-1604 (55 gal)
	MIL-C-16173, Grade 5 (removable film)	8030-00-137-1671 (5 gal)
Petrolatum, hot application	MIL-C-11796, Class 1 (hard film)	8030-00-231-2354 (1 lb) 8030-00-597-3288 (35 lb) 8030-00-231-2352 (400 lb)
Corrosion preventive com- pounds:		
Petrolatum, hot application	MIL-C-11796, Class 1A (hard film, non-stick)	8030-00-514-1843 (400 lb)
Deck covering compound, non- slip, high durability: Dark gray (color 36076) Haze gray (color 36270)	MIL-C-24667, Type I	
Deck covering compound, non- slip, standard durability: Dark gray (color 36076) Haze gray (color 36270) Red (color 31136) White, 55% min. reflectance Yellow (color 33538)	MIL-C-24667, Type II	
Deck covering compound, non- slip, resilient deck covering:	MIL-C-24667, Type III	
Deck covering compound, spray-on non-slip: Yellow Red Olive drab Haze gray Dark gray Dull black White	MIL-C-24667, Type IV	
Detergent, general purpose water soluble	MIL-D-16791, Type I	7930-00-282-9699 (1 gal) 7930-00-985-6911 (5 gal)
Diammonium phosphate	Tech. Grade	6810-00-174-1821 (100 lb)
Enamel gloss:	MIL-PRF-26435, Type II, Fed Std 595 color number:	

Table 631-3-6 MATERIALS WITHOUT FORMULA DESIGNATIONS -

Continued

Material	Specification	NSN's
Off-white	17886	8010-01-433-8385 1 qt 8010-01-433-8380 1 gal 8010-01-433-8391 5 gal
Gray white	17875	8010-01-360-8067 1 gal 8010-01-344-6699 5 gal
Blue white	17877	8010-01-381-3079 1 gal
Bright white	17925	8010-01-397-3935 1 gal
Purple	17142	8010-01-433-8375 1 qt 8010-01-433-8388 1 gal
Light gray	16376	8010-01-375-2175 1 gal
Dark gray	16081	8010-01-433-8384 1 qt 8010-01-433-8379 1 gal
Light green	14449	8010-01-433-8370 1 qt 8010-01-433-8369 1 gal
Medium green	14110	8010-01-433-8364 1 qt 8010-01-433-8366 1 gal
Dark green	14062	8010-01-349-9007 5 gal
Light blue	15200	8010-01-433-8382 1 qt 8010-01-433-8373 1 gal
Dark blue	15044	8010-01-433-8371 1 qt 8010-01-433-8374 1 gal
Clear blue	15177	8010-01-433-8372 1 qt 8101-01-433-8377 1 gal
Blue striping	15123	8010-01-396-6797 1 qt 8010-01-349-9009 5 gal
High-light buff	13578	8010-01-433-8363 1 qt 8010-01-433-8368 1 gal
Tan	10324	8010-01-433-8367 1 qt 8010-01-433-8365 1 gal
Brown striping	10075	8010-01-433-7737 1 qt 8010-01-433-8376 1 gal
Yellow	13538	8010-01-396-6805 1 gal 8010-01-349-9005 5 gal
Red	11105	8010-01-396-6803 1 qt 8010-01-396-6798 1 gal 8010-01-349-9006 5 gal
Orange	12246	8010-01-433-8361 1 qt 8010-01-433-8381 1 gal
International orange	12197	8010-01-396-6805 1 gal 8010-01-349-9005 5 gal
Black	17038	8010-01-350-5239 1 gal 8010-01-344-6695 5 gal
Enamel, silicone alkyd copolymer (semigloss): White (color 27886) Haze gray (color 26270)	MIL-E-24635 MIL-E-24635	8010-01-344-6690 (5 gal) 8010-01-344-5311 (1 gal) 8010-01-344-5309 (5 gal)

Table 631-3-6 MATERIALS WITHOUT FORMULA DESIGNATIONS -

Continued

Material	Specification	NSN's
Epoxy polyamide, clear topcoat for weapons	MIL-C-22750	8010-00-896-1980 (2 gal kit)
Linseed oil (raw)	TT-L-215	8010-00-656-1639 (5 gal)
Neoprene coating:	MIL-R-15058, Type IV	
Brushing cpd and accelerator		8030-00-285-3708 (5 gal)
Priming cement		8030-00-891-9702 (5 gal)
Trowelling material and accelerator		8030-00-285-1568 (1 lb)
Galvanizing Repair Paint	MIL-P-21035	8010-01-501-5798 (16 oz) 8010-01-360-3369 (1 gal)
Tie Cement	MIL-R-15058, Type IV	8030-00-285-1569 (1 gal)
Oakam, marine	T-O-56, Class 1	5330-00-191-5679 (50 ft/lb)
Enamel, Silicone alkyd Light Gray #26373	MIL-E-24635	8010-01-344-5318 (1 gal)
Enamel, Silicone alkyd Ocean Gray #26173	MIL-E-24635	8010-01-344-5316 (1 gal)
Paint, heat resistant	TT-P-28*	8010-00-664-7468 (1 qt) 8010-00-815-2692 (1 gal) 8010-00-857-1938 (5 gal)
Paint and Varnish Remover: Remover: For horizontal surfaces For vertical surfaces	TT-R-251, Type III Class A, low viscosity Class B, high viscosity	8010-00-160-5799 (1 qt) 8010-00-597-8234 (1 gal) 8010-00-165-4447 (5 gal) 8010-00-160-5800 (1 gal) 8010-00-286-2861 (5 gal)
Powder coating	MIL-C-24712	- - -
Primer, lead and chromate - free	MIL-P-52995	- - -
Putty, linseed oil type	TT-P-791, Type II	8030-00-243-0953 (4-1/2 lb)
Repair kit, glass reinforced plastic laminate	MIL-R-19907	2090-00-372-6064
Rubber preservative: Black Olive drab	MIL-P-11520	8030-00-201-1103 (1 gal) 8030-00-656-1030 (5 gal)
Sealant 3M Scotch-weld 2216 B/A gray		8040-00-145-0019 (1 pint kit) 8040-00-145-0530 (1 quart kit)
Sealing compound, wood bedding	MIL-S-19653 Type 1 (use without fabric) Type 2 (use with fabric)	8030-00-579-8890 (1 gal) 8030-00-579-8891 (5 gal) 8030-00-579-8888 (1 gal) 8030-00-579-8889 (5 gal)
Sodium hydroxide	O-S-598, Type I	6810-00-174-6581 (100 lb)
Sodium nitrate	U.S.P. Grade	6505-00-180-9987 (100 lb)
Solvents: Coal tar naphtha Ethyl alcohol (denatured) Super high-flash naphtha	TT-N-97 MIL-E-463 TT-E-781	6810-00-244-1207 (55 gal) 6810-00-222-2373 (5 gal) 6810-00-285-4309 (1 gal) 6810-00-222-2751 (5 gal)

Table 631-3-6 MATERIALS WITHOUT FORMULA DESIGNATIONS -

Continued

Material	Specification	NSN's
Solvents: Mineral spirits	TT-T-291, Grade 1	8010-00-242-2089 (1 gal) 8010-00-558-7026 (5 gal) 8010-00-246-6166 (55 gal)
Synthetic Enamel thinner	TT-T-306	8010-00-160-5794 (1 gal) 8010-00-160-5795 (5 gal)
Ready mixed chlorinated alkyd colors	DOD-E-24607 Fed Std 595 colors	
Beach sand	22563	8010-01-344-5085 (1 gal) 8010-01-344-5096 (5 gal)
Yellow gray	26400	8010-01-344-5093 (1 gal) 8010-01-344-5104 (5 gal)
Green gray	26496	8010-01-344-5092 (1 gal) 8010-01-344-5103 (5 gal)
Rosewood	22519	8010-01-344-5086 (1 gal) 8010-01-344-5097 (5 gal)
Sunglow	23697	8010-01-344-5088 (1 gal) 8010-01-344-5099 (5 gal)
Clipper blue	24516	8010-01-344-5087 (1 gal) 8010-01-344-5098 (5 gal)
Pearl gray	26493	8010-01-344-5094 (1 gal) 8010-01-344-5105 (5 gal)
Pastel blue	25526	8010-01-344-5095 (1 gal) 8010-01-344-5106 (5 gal)
Sigma Coating Co. edge retentive coating system: Sigmaguard primer 7404 Sigmaguard aqua-green topcoat 7451-5674 Sigmaguard gray topcoat 7451		8010-01-434-2119 kit (1 gal) 8010-01-434-2121 kit (4 gal) 8010-01-434-2105 kit (1 gal) 8010-01-434-2110 kit (5 gal) 8010-01-434-2085 kit (1 gal) 8010-01-434-2101 kit (1 gal)
Wood filler	TT-V-336	8010-00-243-0963 (1 gal)
Wood preservative, oil soluble: Copper naphthanate Chlorinated phenol	MIL-W-18142 Type A Type B	8030-00-281-2724 (55 gal) 8030-00-281-2717 (5 gal) 8010-00-281-2718 (55 gal)

631-3.4.5 PAINT STOREROOM. Paints on board naval ships shall be stored in a storeroom designated for flammable liquids (paint locker). The storeroom should be clean, cool, and dry.

631-3.4.5.1 Paint Storage. Paints shall be stored in tightly sealed cans and marked with the name, formula number, and manufacture date. When new stock is obtained, it should be stored so that the oldest paint will be used first.

631-3.4.5.2 Paint Inspections. The contents of any paint container more than 2 years old shall be inspected. If uncertain as to whether the paint is suitable for reworking, particularly where large quantities are involved, send

representative samples to the Laboratory Division of the nearest Naval Shipyard, to NAVSSES, or to the Paint Branch, Annapolis Laboratory of the David Taylor Research Center.

631-3.4.6 PAINT SHELF LIFE CODES. Paint, varnish, and lacquer supplies are generally classed for shelf life under the codes listed in NAVSUPPUB 4105, Navy Shelf Life Items. The shelf life codes are defined in the following paragraphs.

631-3.4.6.1 Code 4: Initial Shelf Life. Code 4 means 12 months initial shelf life from manufacture date.

631-3.4.6.2 Code T4: Shelf Life Extension. Code T4 means to test the paint and, if it is found acceptable, to extend the shelf life for an additional 12 months. The code T should be interpreted as usability testing, which can be carried out at the storage site, rather than specification testing, which requires instrumentation found only in a chemical laboratory.

631-3.4.6.3 Code L: Laboratory Analysis. Code L means to perform laboratory analysis of paint products (to meet original specification requirements) only when questionable properties are observed during usability testing.

631-3.4.6.4 Code RD: Additional Shelf Life Extension. Code RD means to replace any deteriorated paint container and repackage the paint product. Perform laboratory analysis to see if the paint meets original specification requirements and, if found acceptable, return the paint to stock as RFI (ready for issue).

631-3.4.6.5 Code X: Termination of Shelf Life Extension. Code X means that the item is no longer usable and is surveyed; this shelf life code is rarely encountered with paint products.

631-3.4.7 PAINT USABILITY TESTING. As the explanations of the shelf life codes indicate, paint and powder coating products require frequent extensions of shelf life, using simple on-site methods of usability testing such as drying time, color, gloss, leveling, and uniformity of film and resorting to laboratory analysis only in instances where questionable paint properties are encountered.

631-3.4.7.1 The procedure used for testing the paint and powder coating for shelf life extension is as follows:

1. Open one container from each separate batch number. For liquid paint, stir the paint product. The stirred paint product should result in a uniform mixture free of abnormal clumping, jelling, skinning, or other objectionable properties, and comply with procurement documents as described in FED-STD-793, Appendix S - FSC 8010. Acceptable quality level and length of time for shelf extension shall be in accordance with FED-STD-793, Appendix S. For powder coatings, the powder coating shall be free of solvent, water, and free flowing.

631-3.4.7.2 For liquid paints, apply a coating of the test paint on a small panel. It should dry in accordance with the material purchase document (see FED-STD-793) to give a uniform film. Two component paints should be mixed in the appropriate proportions and similarly tested. For powder coatings, apply a coating of the powder coating to a small panel and check for compliance to military specification MIL-C-24712 and UIPI 0631-901. Consult NAVSEA for the extent of allowable deviation from the purchase document.

631-3.4.7.3 Documentation of shelf life extension of paint products at an industrial activity shall be retained by the Supply Department and by the Laboratory Division of the Quality Assurance Office.

631-3.4.8 COATING SELECTION. Since the previous edition of **NSTM Chapter 631**, health, safety and environmental considerations have resulted in reformulation of some paints. Also, some paint specifications have been cancelled and replaced with safe and environmentally compliant materials. [Table 631-3-7](#) identifies new coatings which are specified in this manual and the materials they are replacing. In some cases the replacement coating is a reformulation of the previous material and in other cases specifications have been cancelled and replaced with alternate compliant materials. The new materials are lead and chromate free (lead and chromate < 0.06% in the dry film) and comply with Federal, state and local regulations restricting the emission of volatile organic compounds (VOC) to the atmosphere.

631-3.4.9 NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAP). The Federal Environmental Protection Agency (EPA) has issued a federal regulation entitled "National Emissions Standards for Hazardous Air Pollutants (NESHAP) for Shipbuilding and Ship Repair Operations", effective November 15, 1996. This particular NESHAP limits the amounts of hazardous air pollutants (HAPS) in marine coatings. The NESHAP allowable limits for HAPS are equal to the Volatile Organic Compound (VOC) of the coating (paint). Fleet and shore activity compliance to the NESHAP may be attained by utilizing the low VOC, low lead, low chromate, and low HAPS paints listed in [Table 631-3-7](#). The NESHAP also requires improved worker practices to reduce the release of paint vapors into the air: (1) personnel applying marine coatings are required to reduce paint solvent emissions by maintaining tight-fitting covers on paint containers when the paint is not being used, (2) solvent-soaked cleaning rags shall be kept in bags or containers that are normally closed when not in use, (3) the handling transfer and storage of coatings or solvents shall be accomplished in such a manner so as to minimize spills, and (4) cleaning of equipment shall be conducted in a manner to minimize vapor release and to capture cleaning solvents in normally closed containers. In addition to improved work practices, the NESHAP will also require general record keeping and reporting of coating usage compiled each calendar month.

Table 631-3-7 CHROMATE FREE/VOC COMPLIANT MATERIALS

OLD MATERIAL	NEW MATERIAL	NOTES
TT-P-28	TT-P-28 (Low VOC)	Available through GSA
TT-E-489	MIL-E-24635	Use Gloss Colors
TT-E-490	MIL-E-24635	Use Semi-gloss Colors
TT-P-645A	TT-P-645B	Note use of "B" revision
DOD-E-698	MIL-E-24635	Use old spec. in 08 areas
DOD-E-699	MIL-E-24635	Use old spec. in 08 areas
DOD-E-700	MIL-E-24635	Use old spec. in 08 areas
DOD-E-1115C	DOD-E-1115D	Use only in 08 areas
DOD-E-1265	MIL-E-24635	
TT-P-1757	TT-P-645B	Can also use MIL-P-24441
MIL-E-15090C	MIL-E-15090D	
MIL-E-15129	MIL-E-24635	
DOD-P-15146	MIL-E-24635	
MIL-P-15183	MIL-E-24535	
DOD-P-15328	TT-P-645	Can also use MIL-P-24441
MIL-P-15929	MIL-P-24441	
MIL-E-15935	MIL-E-24635	
MIL-E-15936	MIL-E-24635	
MIL-C-16173D		Use MIL-C-16173
MIL-E-16188	MIL-E-24635	
MIL-P-16738	MIL-E-24635	
MIL-P-17545	TT-P-645	Can also use MIL-P-24441

Table 631-3-7 CHROMATE FREE/VOC COMPLIANT MATERIALS -

Continued

OLD MATERIAL	NEW MATERIAL	NOTES
MIL-E-17970	DOD-E-24607	
MIL-E-17971	DOD-E-24607	
MIL-E-17972	DOD-E-24607	
MIL-E-17973	DOD-E-24607	
MIL-E-17974	DOD-E-24607	
DOD-E-18210	MIL-E-24635	
DOD-E-18214	MIL-E-24635	
MIL-P-19451	MIL-P-15931	Can also use MIL-P-24647
MIL-P-19452	MIL-P-15931	Can also use MIL-P-24647
MIL-P-19453	MIL-P-24441	
MIL-E-20090	MIL-E-24635	
MIL-P-22298	MIL-P-24631	
MIL-P-22299	DOD-P-24631	
MIL-P-23316	TT-P-645	
MIL-P-23377	MIL-P-24441	Use MIL-P-24441, Formula 150
MIL-E-24292	MIL-P-24441	
MIL-E-24306	MIL-P-24441	
MIL-E-24307	MIL-P-24441	
DOD-P-24588	MIL-P-24647	
DOD-P-24655	MIL-P-24647	

SECTION 4**RECONDITIONING OF FLOODED AND SMOKE-CONTAMINATED EQUIPMENT****631-4.1 GENERAL**

631-4.1.1 INTRODUCTION. Shipboard electronic, electrical, and mechanical equipment may become flooded with fresh water, seawater, fuel, lubricating oil, or a combination of these contaminants; or may be contaminated by smoke during fire or other casualty. The replacement or repair of this equipment is important to the ship's operation; therefore, it is imperative that equipment be restored to operational condition.

631-4.1.1.1 Since reliability of the equipment is important, the equipment shall be restored as nearly as possible to new condition. Experience shows that most equipment can be successfully reconditioned, but it must be thoroughly done to minimize the possibility of subsequent failure.

631-4.1.1.2 This section covers reconditioning methods applicable to electronic, electrical, and mechanical equipment such as:

- a. Digital computers
- b. Radar transmitters, receivers, and consoles
- c. Fire control equipment

- d. Radio transmitters and receivers
- e. Amplifiers and power supplies
- f. Teletypewriters
- g. Switchboards
- h. Motors, 5-horsepower and under
- i. Electronic test equipment.

631-4.1.1.3 Depending on the extent and number of equipments requiring repair, restoration of contaminated equipment may be accomplished at depot, intermediate, or organizational levels. Naval Shipyards are recommended as sources of assistance where extensive restoration is required, and other industrial activities, e.g., Naval Air Rework Facilities, may also be able to provide assistance in emergencies.

631-4.1.1.4 The following equipment, except as stated, is not reconditioned at the organizational level:

- a. Electric motors too large or too heavy to be placed in an oven for drying except motors with sealed insulation may be cleaned and bearings replaced at depot level (**NSTM Chapter 302, Electric Motors and Controllers**).
- b. Motors having faulty windings (**NSTM Chapter 302**).
- c. Radial equipment, infrared sensors, and sonar transducers (**NSTM Chapter 400, Electronics**).

631-4.1.2 RECONDITIONING SURFACES. Bulkheads and other general shipboard surfaces should be cleaned using the specified precleaner or detergent solutions. Cleaning emulsion should be used only if precleaner and detergent are inadequate. Shipboard applications of cleaning emulsion shall comply with the personnel and fire protection measures specified in section 2 for paint application.

631-4.2 RECONDITIONING EQUIPMENT

631-4.2.1 GENERAL. The equipment used in reconditioning flooded or smoke-contaminated equipment is described in the following paragraphs.

631-4.2.2 ULTRASONIC TANKS. Two stainless steel ultrasonic tanks large enough to immerse the equipment to be cleaned are needed. Each tank should be equipped with drains and steam or electric heaters. The transducers (preferably magnetostrictive) should be side-mounted, immersible units. For small tanks, bottom-mounted transducers are suitable. The energy input should be 6 to 10 watts per square inch over the entire side or bottom of the tank. Use one tank for cleaning and the other for rinsing. A third tank (without the transducer) may be used for presoaking smoke-contaminated items.

631-4.2.3 SPRAY EQUIPMENT. Pressure-atomizing (airless) spray guns, such as those used for aircraft washing, are preferred. Compressed air guns are also suitable.

631-4.2.4 COMPRESSED AIR. Oil-free air at about 80 lb/in² is needed for spraying equipment. Air for blowing off bulk water before drying shall be clean, dry, oil-free, and reduced to 10 to 20 lb/in² .

631-4.2.5 DRYING EQUIPMENT. Vacuum or forced-draft ovens with the temperature reliably controlled at 49 to 71°C (120 to 160°F) are preferable for drying the cleaned items. A room equipped with heaters or dehumidifiers can also be used. Warm air blowers are useful, but high-temperature heat guns may cause damage.

631-4.3 RECONDITIONING MATERIALS

631-4.3.1 GENERAL. The materials needed in the reconditioning of flooded or smoke-contaminated equipment are:

- a. Precleaners for smoke and soot deposits
- b. Detergents for cleaning
- c. Cleaning emulsions for oily contamination, preservatives, and salts
- d. Water-displacing fluids for temporary preservation and drying electronic and electrical equipment.

631-4.3.2 PRECLEANER. Use an alkaline cleaning agent to clean the smoke and soot deposits from smoke-damaged equipment. Use 2 to 3 ounces of trisodium phosphate (technical grade, NSN 6810-00-664-7487) per gallon of water (1 to 1-1/2 pounds per cubic foot) at 49 to 71°C (120 to 160°F). Workers shall wear rubber gloves and safety goggles to minimize contact with the alkaline solution. In an emergency, an alkaline cleaning agent such as a dishwashing compound may be used.

631-4.3.2.1 If trisodium phosphate is not available through normal channels, it can be obtained from the following sources:

Ashland Chemical Company
Box 2219
Columbus, OH 43216

Fisher Scientific Company
585 Alpha Drive
Pittsburgh, PA 15238

Olin Corporation
120 Long Ridge Road
Stamford, CT 06904

631-4.3.3 DETERGENT. For cleaning equipment with little or no oily contamination, use a general-purpose water-soluble detergent (MIL-D-16791, Type I). Mix 1 ounce per gallon of fresh water (1 gallon per 125 gallons or 17 cubic feet). Detergent MIL-D-16791 is available in 1- and 5-gallon cans. (See [Table 631-3-6](#) for NSN's.)

631-4.3.4 CLEANING EMULSION. Cleaning emulsion is used for removing oily contamination, preservatives, and salts from flooded equipment. The emulsion concentrate ([Table 631-4-1](#)) comprises the following:

CAUTION

These fluids are flammable and moderately toxic. They shall be used in well-ventilated areas away from open flames or other ignition sources. Personnel shall wear rubber gloves to prevent skin contact.

1. Dry cleaning solvent, FED Spec. P-D-680, Type II.
2. Fuel oil, diesel marine, MIL-F-16884, Type I.
3. Surfactant, polyethylene glycol, 400 dioleate.

631-4.3.4.1 The mixing formula for the emulsion concentrate is 94 parts of dry cleaning solvent to 5 parts fuel oil to 1 part surfactant. The surfactant is available from the following sources:

Armak Chemical Division
Box 1805
Chicago, IL 60609
Order: polyethylene glycol 400 dioleate

Emery Industries, Inc.
Carew Tower
Cincinnati, OH 45202
Order: Emerest 2648

Glyco Chemicals, Inc.
P.O. Box 700
Greenwich, CT 06830
Order: Pegosperse 400 DO

631-4.3.4.2 Fill the clean tank 20 to 50 percent with cleaning emulsion concentrate and then add fresh water. The mixing formula for the emulsion concentrate is given in [Table 631-4-1](#). The water shall have a hardness of less than 10 p/m. Upon mixing, the emulsion will readily form and should begin to separate after standing for about 30 minutes. Rapid separation indicates excessive water hardness.

631-4.3.4.3 In an emergency, general-purpose oil-soluble detergent (MIL-D-16791, Type II) may be used for the surfactant, even though the emulsion concentrate will not have the optimum properties.

631-4.3.5 WATER-DISPLACING FLUIDS. Water-displacing fluid (Formula No. 1) is used for the temporary preservation of any equipment pending cleaning, and for drying mechanical and electrical equipment, except for electrical contacts. Water-displacing fluid (Formula No. 2) is used for drying electronic equipment and electrical equipment having open contacts. These fluids, packaged in aerosol spray cans, may be obtained as Spray-Dri, Formula No. 1 or No. 2 from:

Table 631-4-1. EMERGENCY CLEANING EMULSION CONCENTRATE FORMULA

Ingredients	Small Batch (5.32 gal)	Large Batch (58.5 gal)
Solvent (P-D-680, Type II)	5 gal	55 gal
Diesel fuel oil (MIL-F-16884, Type I)	1.1 qt (1 L)	2.9 gal (11 L)
Surfactant	6.8 fl oz (200 mL)	75 fl oz (2200 mL)

Orb Industries
P.O. Box 1067
Upland, PA 19015

631-4.3.5.1 Water-displacing fluids may also be locally prepared for application with paint-spraying equipment (Table 631-4-2).

631-4.3.5.2 The components that make up the water-displacing fluid are available from the following sources:

- a. N-Butyl alcohol, technical grade (1-butanol), NSN 6810-00-281-2685 (5 gal):

Fisher Scientific Company
585 Alpha Drive
Pittsburgh, PA 15238

Gallard-Schlesinger Chemical
Manufacturing Company
584 Mineola Avenue
Carle Place, NY 11514

- b. Basic barium dinonylnaphthalene sulfonate (50 percent concentration in naphtha). Specify as Na-Sul BSB in naphtha:

R.T. Vanderbilt Company, Inc.
30 Winfield Street
Norwalk, CT 06855

- c. Anti-oxidant BHT, available from R.T. Vanderbilt Company as Vanlube PC.

Table 631-4-2. WATER-DISPLACING FLUID FORMULAS

Components	Formula No. 1 (by parts)	Formula No. 2 (by parts)
N-Butyl alcohol	93.75	98.75
Basic barium dino-nylnaphthalene sulfonate (50% concentrate in naphtha)	6.0	1.0
Anti-oxidant BHT	0.25	0.25

631-4.4 RECONDITIONING PROCEDURE

631-4.4.1 GENERAL. The reconditioning procedure consists of five steps described in the following paragraphs.

631-4.4.2 PREPARATION. Unprotected ferrous metals in submerged equipment will rust rapidly when exposed to air (**NSTM Chapter 300, Electric Plant, General**). Arrangements should be made to immediately proceed with the reconditioning operation after dewatering or recovery of the equipment. Complete disassembly of contaminated equipment is unnecessary. It shall be opened to allow the cleaning solution to reach all contaminated areas, and to allow the cleaning solution to reach all contaminated areas, and to allow complete draining, rinsing, and drying. Remove covers and access panels, cut ties on large wire bundles, and loosen cable connector boots. Remove fuses and panel lights, unless complete access is required for superficial contamination is caused by light smoke or by a brief, light spray of seawater.

631-4.4.3 PRECLEANING AND TEMPORARY PRESERVATION. Equipment flooded with seawater should be flushed with or immersed in freshwater as soon as possible. If cleaning cannot be completed within a few days after flooding, a preservative should be applied to prevent corrosion. Water-displacing fluid (Formula No. 1) is preferred. If unavailable, corrosion-preventive Grade 3 of MIL-C-16173 or some other readily removable preservative may be used.

631-4.4.4 CLEANING AND RINSING. Immersion in an ultrasonic tank is the most effective means of cleaning. It is essential for complex electronic equipment and large electric motors. Air dissolve in the cleaning solution reduces the scrubbing action, so freshly filled tanks should be deaerated by allowing tank to run for 15-30 minutes before use. The temperature should be between 38 and 57°C (100 and 135°F).

631-4.4.4.1 General. Items being cleaned should be suspended in the tank and turned occasionally. Small parts and hardware may be cleaned in cans suspended or floating in the tank. Immersion for 2-3 minutes is usually adequate for circuit boards, 5-10 minutes for complete chassis, and 10-20 minutes for motors. After cleaning, the item should be briefly flushed with fresh water, then rinsed in the purest available water in an ultrasonic tank in the same manner. Spray-cleaning equipment may be used on racks, cabinets, switchboards, and similar equipment that cannot be moved or that is too large for the ultrasonic tanks. Rinsing can be done with the same equipment or a small fresh water hose.

631-4.4.4.2 Fire and Smoke. Heavy adherent contamination may require presoaking in a tank of trisodium phosphate solution (paragraph [631-4.3.2](#)) at 49 to 71°C (120 to 160°F) for 2 to 5 minutes. Presoaked items, or those with only light contamination, are then cleaned as described in paragraph [631-4.3.3](#). Items with moderate or oily contamination or with preservatives present are cleaned as described in paragraph [631-4.3.4](#).

631-4.4.4.3 Oil or Oil and Seawater. The cleaning emulsion specified in paragraph [631-4.3.4](#) removes oil contaminants and salts. The concentrate is mixed with fresh water to form the emulsion. Depending upon the amount of oil contaminant, use 20 to 50 percent of the concentrate. After cleaning (preferably ultrasonically), flush and rinse thoroughly using the same procedure. If spraying, occasionally stir the emulsion to prevent separation, then proceed with drying.

631-4.4.4.4 Seawater. If little or no oily contamination is present, a detergent solution prepared with fresh water is used for cleaning. Flush and rinse thoroughly and proceed with drying.

631-4.4.4.5 Fresh Water. If the flooding water was of potable quality or purer and carried no other contaminants into the equipment, flush with pure fresh water and proceed with drying. If mud, oil, salts, or dirt are present, proceed as described in paragraphs [631-4.3.2](#) or [631-4.3.4](#).

631-4.4.5 DRYING. Drying may be done by blowing the water off the equipment with oil-free, low-pressure air (10 to 20 lb/in²). Place the equipment in a warm oven 49 to 71°C (120 to 160°F) until dry (8 to 24 hours).

CAUTION

Do not use oily moisture-displacing sprays on electronic equipment.

631-4.4.5.1 For large items or if an oven is not available, the water-displacing fluid (Formula No. 2) may be used to speed-dry and prevent corrosion.

631-4.4.6 CHECKOUT. Electronic and electrical equipment shall be checked for proper operation, defective components, and high insulation resistance. Adjustment and realignment may be necessary before returning the equipment to service.

631-4.5 RECONDITIONING EQUIPMENT REQUIREMENTS

631-4.5.1 GENERAL. Some guidelines that may be helpful when reconditioning flooded or smoke-contaminated equipment are given in the following paragraphs.

631-4.5.2 UNSEALED VOIDS. Some components, such as panel meters and synchro and servo motors, have cases which are not hermetically sealed, but are tight enough to prevent adequate cleaning, rinsing, and drying. Sometimes these can be opened and the contents cleaned, but replacement is often cheaper. If the contamination is superficial, remove such items in the preparation procedure and manually clean as necessary.

631-4.5.3 LUBRICATED PARTS. Discard oil wicks before cleaning equipment and replace with new ones. Replace sealed bearings after cleaning. Relubricate gears, cams, and other components.

631-4.5.4 MOTORS AND GENERATORS. Spray cleaning is adequate only for fractional-horsepower AC units. For larger units and all DC equipment, use ultrasonic agitation. Disassemble the unit, discarding carbon brushes, sealed bearings, oil wicks, and packing. Clean the rotor and stator separately. After drying, reassemble and relubricate as necessary. Operations shall not be attempted until the circuit-to-ground resistance exceeds 8,000 ohms as measured by null balance methods. High potential insulation resistance measurements shall never be made while insulating systems are wet or damp. Equipment may be started at reduced voltage and operated for several hours under no load or very light load to produce gently internal heating to complete the drying until the resistance between the circuit and ground exceeds the following:

- a. One megohm for equipment rated at 450 volts or less.
- b. A value in megohms equal to rated voltage divided by 500 for equipment rated over 450 volts.

631-4.5.4.1 Failure to reach a satisfactory insulation resistance level, or a decline in resistance afterward, is an indication that salts are still present and a more thorough (longer) cleaning is required.

REAR SECTION

NOTE

TECHNICAL MANUAL DEFICIENCY/EVALUATION EVALUATION
REPORT (TMDER) Forms can be found at the bottom of the CD list of books.
Click on the TMDER form to display the form.

